OCT 15 1930

INDUSTRIAL ENGINEERING

MAINTENANCE ENGINEERING
IN PLANTS, MILLS, AND FACTORIES

A McGraw-Hill Publication
25 Cents per copy

OCTOBER-1930

For Cover Story
see page 534

....There is only ONE TEXROPE DRIVE

It is made by Allis-Chalmers

and its use assures perfect performance!

Internal friction is minimized. The fabric section is used to maintain proper form and position of Texropes in grooves. Outer wrapping keeps moisture or dirt out of cord section and retains belt structure intact.

SO attractive are the savings effected with Texrope Drives that over 80,000 have been sold. Wherever correctly applied they have never failed to give complete satisfaction.

In originating and developing this drive that has revolutionized transmission methods, Allis-Chalmers has achieved the perfection that comes only after years of practical experience.

Texrope Belts possess amazing flexibility and long life. The process by which they are made is the result of every facility of The B. F. Goodrich Rubber Company and the vast Allis-Chalmers organization. The belt cores are built by a special process . . . the outer wrapper prevents dirt from working into the cord section. The belts are formed in accurately machined molds. They always seat perfectly.

In the manufacture of grooved sheaves Allis-Chalmers has secured the perfect balance so necessary to vibrationless operation . . . and the accurate machining that assures perfect seating of belts and unusually long service.

So rapidly have Texrope Drives completely smashed transmission tradition that many imitations are now being offered . . . and the word "Texrope" is often used in referring to *all* V-belt drives.

When you are buying V-belt drives, be *sure* to get the *genuine Allis-Chalmers Texrope Drives* . . . backed by an organization more than 80 years old in the manufacture of power machinery.

The Whole Story in 8 Minutes

In 8 minutes you can get the whole story of Texrope Drives from this illustrated book. *Ask for a copy of Bulletin 1228.*

ALLIS-CHALMERS MANUFACTURING CO.
Texrope Division Milwaukee, Wis.
Specialists in Power Machinery Since 1846

ORIGINATED BY ALLIS-CHALMERS

TEXROPE DRIVES

THE DRIVES THAT REVOLUTIONIZED TRANSMISSION PRACTICE • • •

INDUSTRIAL ENGINEERING

Founded in 1882 as Electrical Review. Consolidated with it—Western Electrician and Industry Illustrated.

Maintenance Engineering in Plants, Mills, and Factories, as Applied to Electrical and Mechanical Equipment and Buildings

L. C. MORROW, *Editor*

Volume 88, Number 10

Contents for October, 1930

Organized Plant Engineering 495
By ALFRED VAKSDAL and JOHN W. ROMIG

Inadequate Wiring Boosts Light Bills 499
By ROY A. PALMER

To Drive These Hydraulic Pumps—One Motor or Six? .. 502
By J. GORDON FLETCHER

Questions and Answers 505

Metering Three-Phase, Four-Wire Systems 507

An Economical Combination Water System 509
By O. P. WILLMS

Starters and Motors 510
By A. A. A. RODRIQUES

Plant Engineers' Forum 515

Policing Electrically 520
By RAYMOND K. HYDE

Editorials 524

Electrical Distribution at Point Breeze 526
By R. G. HORNBERGER and W. A. HALLIDAY

Around the Works 530

Controlled Air at Work 532
By DWIGHT LLOYD

Equipment News and Trade Literature 535

Industrial Engineering's Data Sheets 543

Maintenance on a premium basis is just one of the many organization items in the story on plant engineering activities in the Corning Glass Works. The article starts on page 495.

"Inadequate Wiring Boosts Light Bills," the title completely explains the purpose of the article beginning on page 499. But—to make it more impressive—Roy Palmer has included a set of graphs and figures that should convince the most skeptical.

Chain, belt, group, or individual drive for a battery of six hydraulic pumps? A nice problem—and a nice solution. On page 502.

WILBUR A. BECK
Managing Editor

G. A. VAN BRUNT
Electrical Editor

E. P. SWEENEY
Assistant Editor

JAMES O. PECK
Business Manager

G. E. CONKLING
Publishing Director

M. O. LOKENSGARD
Assistant Publishing Director

COPYRIGHT, 1930, BY
McGRAW-HILL PUBLISHING COMPANY, INC., 520 NORTH MICHIGAN AVENUE, CHICAGO, ILL.

JAMES H. McGRAW, *Chairman of the Board*
MALCOLM MUIR, *President*
JAMES H. McGRAW, JR., *Vice-Pres. and Treas.*
EDWARD J. MEHREN, *Vice-President*
MASON BRITTON, *Vice-President*
EDGAR KOBAK, *Vice-President*
HAROLD W. McGRAW, *Vice-President*
H. C. PARMELEE, *Editorial Director*
C. H. THOMPSON, *Secretary*

MEMBER—A. B. C., A. B. P.

PUBLISHED MONTHLY
$2 PER YEAR
SINGLE COPY 25 CENTS

NEW YORK, *475 Tenth Avenue*
NEW YORK *District Office, 285 Madison Avenue*
WASHINGTON, *National Press Building*
PHILADELPHIA, *1600 Arch Street*
CLEVELAND, *Guardian Building*
ST. LOUIS, *Telephone Building*
SAN FRANCISCO, *883 Mission Street*
LOS ANGELES, *632 Chamber of Commerce Building*
BOSTON, *65 Franklin Street*
GREENVILLE, S. C., *1301 Woodside Building*
DETROIT, *2-257 General Motors Building*
LONDON, *6 Bouverie Street, London, E. C. 4*

Entered as second-class matter Feb. 25, 1929, at the postoffice at Chicago, Illinois, under Act of Congress of March 3, 1879. Printed in U. S. A.

The
"CIRCLE T"
LINE

TYPE "A" INDUSTRIAL SWITCHES
MOTOR STARTING SWITCHES
TYPE "C" SWITCHES
ENTRANCE SWITCHES
METER SERVICE SWITCHES
SPECIAL SWITCHES
PANELBOARDS
SWITCHBOARDS
"BUSS-WA"
(The Copper Bar Distribution System)
"FLEX-A-POWER"
(The convenience outlet for Power in Industry)
"CONTROLITE"
(The Theatre Control Board)
and other devices—all listed in Catalog No. 14

Sold Through Wholesalers

THE TRUMBULL ELECTRIC MFG. CO.

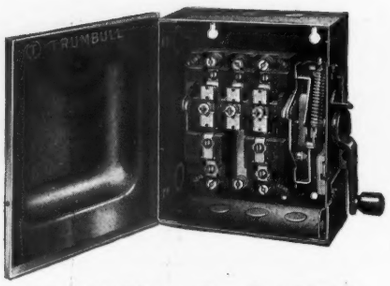
PLAINVILLE, CONNECTICUT

Branch Panelboard and Switchboard Factory at Ludlow, Kentucky

NEW YORK 803 Lincoln Bldg.
PHILADELPHIA 511-519 N. Broad St.
CHICAGO 2001 W. Pershing Rd.
BOSTON 1002 Statler Bldg.
SAN FRANCISCO 432 Fourth St.
DETROIT Branch 415 Brainard St.
ATLANTA

A. G. Electric Mfg. Co. Division Branch Panelboard and Switchboard Factories.—Los Angeles—Seattle

A GENERAL ELECTRIC ORGANIZATION



"T. M. 7½" Motor Starting Switch
With Thermal Overload Protection
Nothing to Renew

A Machine Stalls . . .

what will you see when you open the switchbox?

A machine stalls—a roar from the motor—what will you see when you open the switchbox—the molten remains of what was once a switch?

Or do you enjoy the protection of the "Circle T" Line? Does a Type "T.M." guard each of your motors? In which case the switch will trip, operated by a thermal unit, safely and surely interrupting the heavy current.

And if you do open the cover of a Trumbull Type "T.M." that has tripped (and there's really no need to—there's nothing to renew) you will see the switch as new—no pitted blades—no beads of copper—no burnt insulation—that's the "Circle T" protection.

Of rugged construction and reliable in operation the Type "T.M." will provide you with a dependable form of protection against overload or damage due to phase failure.

May we send you our catalog describing this and other "Circle T" Products?

INDUSTRIAL ENGINEERING

Maintenance Engineering in Plants, Mills, and Factories, as Applied to Electrical and Mechanical Equipment and Buildings

A McGraw-Hill Publication, founded 1882

Volume 88 CHICAGO, OCTOBER, 1930 *Number 10*

ORGANIZED PLANT ENGINEERING

By ALFRED VAKSDAL *and* JOHN W. ROMIG

Plant Engineer *Mechanical Superintendent*

Corning Glass Works
Corning, N. Y.

Glass making demands constant service. A one-minute delay in electric power means a 30-min. delay in production—One reason the Plant Engineering Department of the Corning Glass Works employs 250 men and functions in twelve divisions of plant operation.

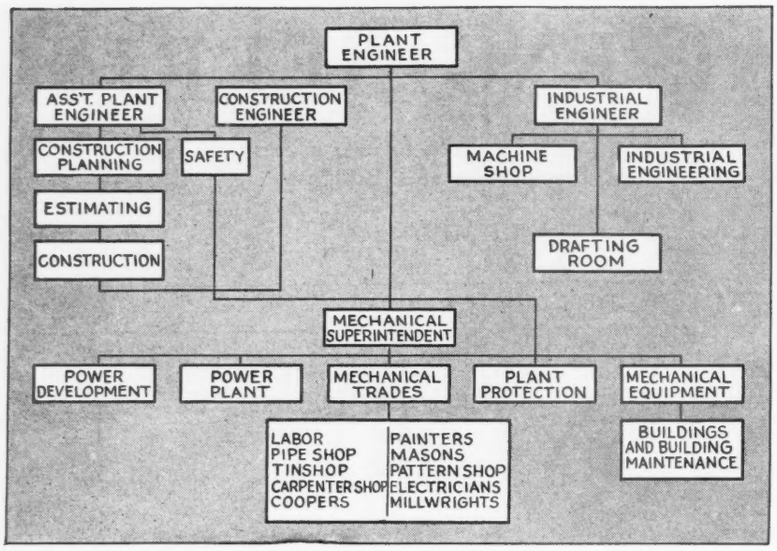
GLASS manufacture imposes many peculiar responsibilities on the plant engineering department. The nature of the services required, the necessity for avoiding interruptions in these services, and the promptness with which breakdowns and emergencies must be handled, make a well-organized engineering department indispensable.

The Corning Glass Works operates two plants in Corning, N. Y., (soon three will be going), a plant in Wellsboro, Pa., and one in Central Falls, R. I. The chief products are radio and lamp bulbs, glass tubing, art ware, high-tension and communication line insulators, domestic ware, chemical ware, airport, railroad, marine and traffic lenses, and many other glass products. In the Corning plant alone 43 buildings are used for housing production and allied operations.

The pipe shop is well equipped to handle any job that may be required of it.

Power is an important factor in the manufacture of glass. Not only is economy necessary, but continuity of service is essential. An interruption of electric power for one minute will cause from five to thirty minutes' interruption in glass manufacture, for the temperature control and the heat balance in manufacturing are basic essentials of production. It is the duty of the plant engineering department to provide this continuity of power service.

It is found economical to operate a power plant that generates about 30,000,000 lb. of steam, furnishes well over a half million kilowatt-hours of electrical energy a month to drive 860 motors with an aggregate rating of 3,000 hp., and provides high- and low-pressure steam,



Organization chart of the plant engineering department at the Corning plant of the Corning Glass Works.

high- and low-pressure air, light, and heat for the offices and plant departments. One of its incidental services is the pumping of 1,000,000 gal. of water a day for various manufacturing and other purposes.

Six kinds of fuel are used to supply the heat required for the different processes and machines. This service alone requires the handling of large amounts of fuel oil, for which there is a storage capacity of 110,000 gal., and the operation of a large producer gas plant.

The work of the plant engineering department is thus widely diversified in the usual branches of engineering, quite specialized along the lines of practice in the glass industry, and extends to a greater or less degree into every phase of plant operation. At present this department employs about 250 men in the twelve divisions under which the various activities are classified.

The plant engineer coordinates the activities of the various branches. An assistant, who assumes responsibility for the department in the absence of the plant engineer, spends a large part of his time on plant development problems, planning for present and future requirements. The assistant also acts in an advisory capacity as safety engineer and on matters relating to fire protection, and janitor and watchman services.

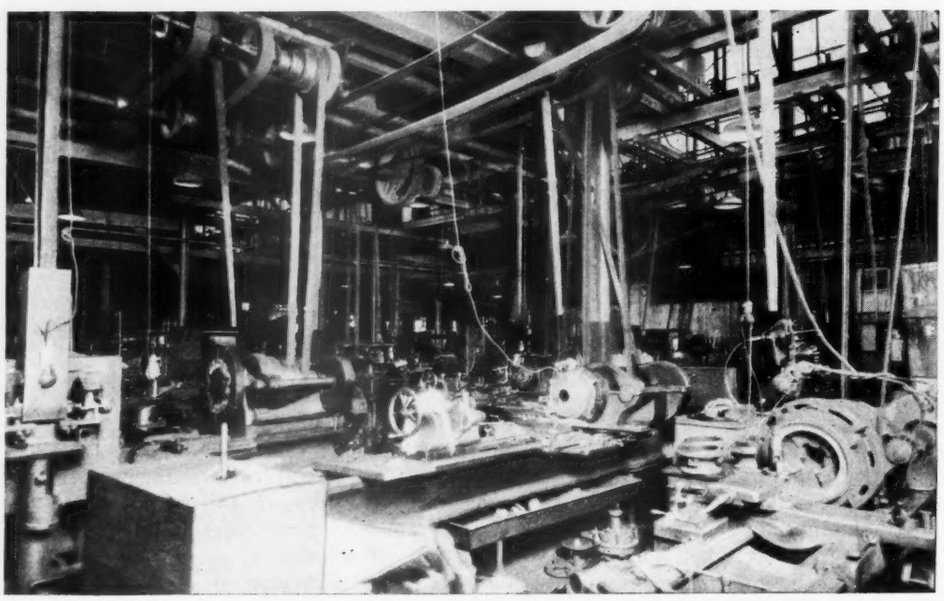
A chief draftsman, reporting to the plant engineer, handles matters pertaining to the design of glass molds, furnaces, and other specialized equipment. The machine shop superintendent reports directly to the plant engineer. Power, power planning, miscellaneous maintenance, plant protection, mechanical planning, and mechanical specifications come under the mechanical superintendent who reports directly to the plant engineer. Also under the supervision of the mechanical superintendent are the trades divisions, including pattern makers, masons, millwrights, carpenter, box making, pipe, and electrical shops, labor department, and the power plant.

One phase of the plant engineering department's activities is consultation on factory layout and methods with the production departments. This work is carried on largely by the plant engineer, although his assistants work on the development of certain phases.

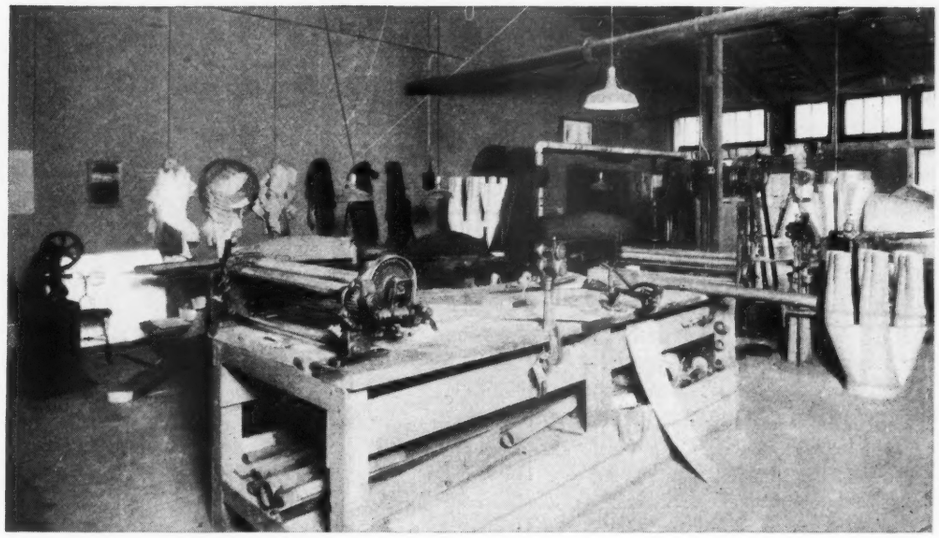
A system of scheduling the work has been developed, whereby each man in each trade division has a place for his name and job cards on the scheduling board of his department. A card is made out for the individual craftsman for each job he does. The scheduling board is arranged so that for each man there is a place for the card on the job being worked on, a place and card for his next job, another place for jobs waiting, and still another for finished jobs.

This system of scheduling, with the foreman seeing that material is on hand and that everything is ready, does away with much lost time on the part of the men. Every night the schedule board is filled for the next day; so every man can start right off on a job in the morning. In this manner lost time caused by a foreman being late, or having to assign jobs to all of his men at one time, is kept very low.

Another advantage lies in the small loss of time between jobs in



The machine shop makes and repairs glass molds, builds new glass-working machines of special design, and handles all maintenance and repair work that involves machining operations.



A corner of the tinshop, in which all of the air ducts and fittings are made.

case the foreman is out when a craftsman comes to the shop after he completes a job. With the schedule board he does not wait for another job, but punches out on the completed work card and punches in on the new one.

Once a system of this kind is in operation, its advantages are readily appreciated. It not only decreases the departmental lost time, but gives the foreman much freedom in supervising men who are out on various jobs in the plant. A foreman can, by being in frequent contact with his men in their work, do much to help them by showing them short cuts, and so on.

Tied in with the scheduling system is a premium system whereby the men are paid for extra effort. The premium system is based on time estimates of the various jobs to be done. Standard time for many jobs has been set, and standards on new work are being developed from day to day. Estimates of the time required to do a job are made and craftsmen who apply themselves diligently have an opportunity to make something extra for the next pay envelope. In January of this year more than 60 per cent of the work done by the trades was on a premium basis. With more than 150 craftsmen working on maintenance, and new and routine work, the advantages of a premium system are many.

The scope of premium work is gradually being broadened and some departments will eventually operate with 90 per cent of the time of the craftsmen being devoted to premium work. An ultimate average of 80 per cent for the entire trades division is anticipated.

One of the incidental advantages of placing work on a premium basis has been that foremen and craftsmen find quicker methods of doing their jobs. A hole will not be drilled if it can be punched in less time without affecting quality. Men will not make three trips for material when one trip will suffice. The quality of work done on premium is kept up, for poor quality of work will cancel premium time. The scheduling system has given foremen time to see that work is properly done.

To show how these systems work in practice, assume that one of the production departments desires to have certain work done. A responsible representative of that department telephones the details to the order clerk of the plant engineering department. The order clerk writes the order in triplicate on the Work Order, shown on page 498, affixes the proper charge number, and gives the original to the mechanical superintendent who determines the necessity for special advice or information before execution.

Orders that require material other than that stocked in the storeroom pass through the material clerk whose duty it is to see that material is on hand for the execution of the order. The orders are then passed to the trades divisions who have to perform the work.

After the foreman receives the order for the work he and the premium clerk set a standard time for the job. Cards are made out for the craftsmen who are to do the work and the job is put through the shop. When finished, the original order is sent to the premium division and the premium time is credited to the craftsmen who have executed their work in less than the set standard time.

Assume that a man is assigned a job for which he is allowed twenty hours, and which he completes in eighteen and one-half hours. He will be paid his regular rate for twenty hours and when he is assigned another job he will receive his regular rate on that job, in addition to his rate for one and one-half hours on the former job. Thus he receives extra compensation for extra effort, and always knows where he stands.

It was noted previously that the assistant plant engineer is responsible for fire protection, safety, and the cleaning and watch services. Two men are assigned to the task of cleaning windows, lamp bulbs, and reflectors. Collection of waste, packing material, and other rubbish is handled by two men, who do nothing else. Three men are employed to keep all of the toilets and washrooms in the plant in a sanitary condition. Four men keep the plant yards and passageways clean and free from discarded materials of all kinds, which are collected and disposed of by two men, with the help of an electric truck. Keeping the offices and showrooms in the proper condition requires the full-time work of four men and two women.

For guarding the entrances and patrolling the plant fifteen men are required—seven during the day and eight at night.

Safety work, which includes inspection of buildings and all equipment, is handled in a fashion somewhat unusual. In addition to the regular inspectors the safety committee appoints on January 1 of each year an inspection committee composed of one foreman from the plant engineering department, one foreman from the manufacturing department, one general inspector, and one representative from an outside safety organization. The plant engineering and manufacturing department members change from month to month, so that at least one new man is always on the committee. A complete inspec-

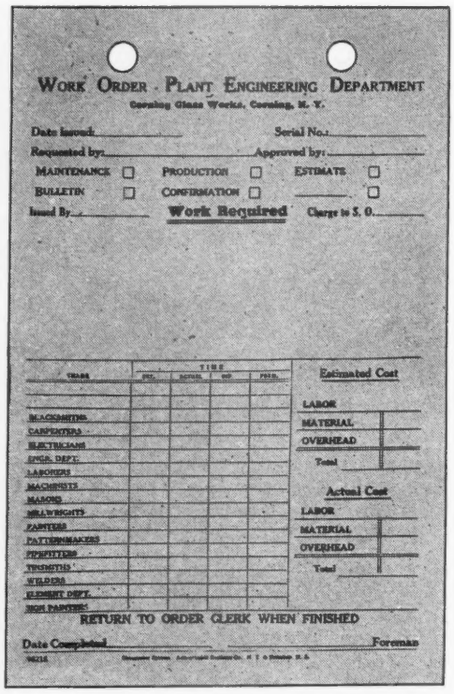
tion of the entire plant is made once a month.

All buildings are examined to detect weak or defective places, bad floors—anything that might be an injury hazard—and places that need painting or repairs are noted. Fire protection equipment, production machines—everything in the plant—is gone over and its condition determined. Anything that the committee feels should be done is put into its report, which is given to the chairman of the safety committee. This committee is composed of all the foremen in the plant, and its recommendations are transmitted to the management for action.

The work of some of the departments under the mechanical superintendent may be outlined as follows: The electrical department handles construction, installation and maintenance work on all electrical equipment,. Important motors and controls are inspected from one to three times a day, depending on the conditions and the importance of the service. Three inspectors and oilers are employed in this work.

To supply the great volumes of air needed for cooling men and equipment requires many thousands of feet of large air ducts. These ducts are subject to damage and abuse in various ways, and in some places rather frequent replacements are necessary. Also, new lines are constantly being put up, so that it is necessary to have a large and well-equipped tinshop for handling this work. All of the ducts and fittings are fashioned from sheet metal.

The engineering department is responsible for much of the building construction and alteration. This department has charge of the construction and maintenance of sewers, water supply, water mains, and fire hydrants, and the layout and installation of conveyors, inasmuch as these may require building alterations.



WORK ORDER - PLANT ENGINEERING DEPARTMENT

Corning Glass Works, Corning, N. Y.

Date Issued: _____ Serial No.: _____

Requested by: _____ Approved by: _____

MAINTENANCE ☐ PRODUCTION ☐ ESTIMATE ☐

BULLETIN ☐ CONFIRMATION ☐ _____ ☐

Issued By: _____ **Work Required** Charge to S. O. _____

TRADE	TIME EST.	TIME ACTUAL	TIME DIF.	TIME PERS.
BLACKSMITHS				
CARPENTERS				
ELECTRICIANS				
ENGR. DEPT.				
LABORERS				
MACHINISTS				
MASONS				
MILLWRIGHTS				
PAINTERS				
PATTERNMAKERS				
PIPEFITTERS				
TINSMITHS				
WELDERS				
ELEMENT DEPT.				
SIGN PAINTERS				

Estimated Cost	
LABOR	
MATERIAL	
OVERHEAD	
Total	

Actual Cost	
LABOR	
MATERIAL	
OVERHEAD	
Total	

RETURN TO ORDER CLERK WHEN FINISHED

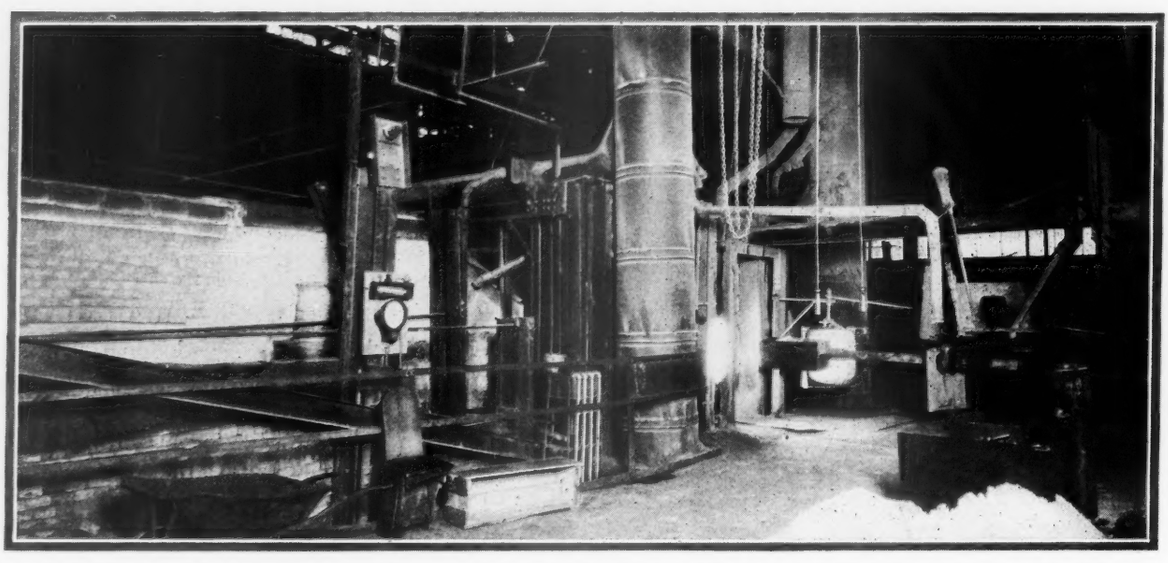
Date Completed _____ Foreman _____

Each trades division concerned receives one copy of this Work Order, which is made out in triplicate. One copy is sent to the mechanical superintendent, and the third is filed by the order clerk.

When requests are made for work that does not involve the expenditure of an excessive sum of money, an analysis of the job and an estimate of the cost are made and a work order is issued.

When a large expenditure will be required for some project, such as the purchase or development of special equipment, or major changes, a request is made for an appropriation. The Appropriation Request form provides spaces for the entry of such items as amount of money requested, purpose, reasons, account to be charged, details of the savings, cost, estimated life, estimated annual fixed and operating expenses and so on.

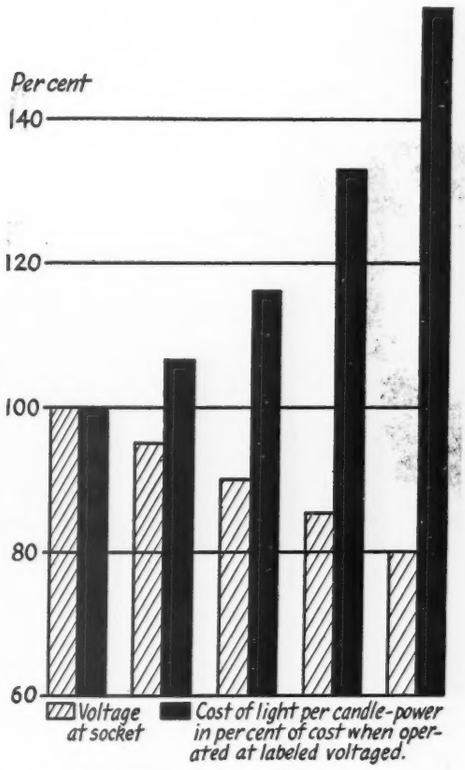
Two copies of the Appropriation Request are set to the persons making the request. After approval by these persons the request and cost estimate are forwarded to the production manager, who in turn presents them to the manufacturing committee for approval. If favorable action is taken by this committee, the request is filed in the president's office to await official approval. If such approval is forthcoming, the plant engineering department is authorized to carry out the project and is given the necessary orders for the work.



Rear end of a glass tank into which the raw materials are fed by the charging device at the right, and melted. Note the large, sheet-metal ducts for conveying cooling air.

INADEQUATE WIRING BOOSTS LIGHT BILLS

By ROY A. PALMER
Illuminating Engineer
Southern Public Utilities Company
Charlotte, N. C.



Cost of light increases as the line voltage drops below the labeled voltage on the lamps.

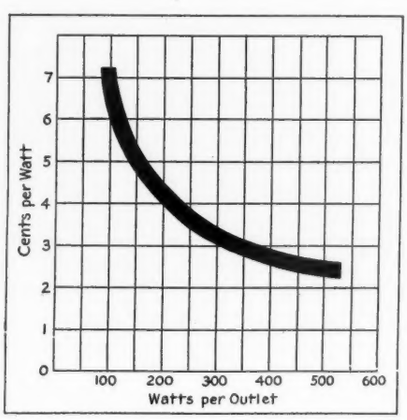
THERE are a great number of industrial plants that are still inadequately lighted, and unfortunately, many of the new factory buildings are equipped with no better facilities for lighting than buildings erected ten or fifteen years ago.

In decreasing spoilage, lowering unit production costs, and promoting employee morale the importance of good lighting has been so definitely proved that no executive can afford to wilfully neglect the lighting in his plant.

These benefits are not in the imagination of promoters; they are actual experiences of plants that have been equipped with lighting systems according to modern standards and practice. Good lighting in the factory is today a part of good management and as such every executive interested in the progress and economical operation of his plant should be informed about those essentials that will provide good lighting and permit changes and additions to the lighting system for future needs at a minimum of cost.

One of the greatest handicaps and the source of greatest expense in providing better lighting is the lack of adequate wiring. A large number of wiring installations have been and still are being put in according to the demands of the National Electrical Code, which specifies only the minimum standard for electrical wiring from a hazard point of view. It is not a standard for adequate wiring.

When an architect specifies that the wiring should be installed in accordance with the code, the contractor, in order to meet competition, bases his bid on the least amount of material necessary within the limits of the code. Too often, as a result, the owner or tenant of the building finds the lighting inadequate even when the building is first occupied, and the condition of the wiring is such that it is not possible to use larger lamps without overloading the circuits. If larger lamps are installed regardless, not only is the hazard increased, but losses in light output of the lamps due to their operation on overloaded circuits will result, which means uneconomical lighting.



Wiring installation cost per watt.

Lighting standards are on the upward trend. We have by no means reached the limit. Looking back a few years, we find that 10-foot candles were considered satisfactory. Today that is ordinary. Twenty, thirty, fifty, and even higher foot-candle values are economically used in hundreds of factories. Most of our factories, however, are still in the dark age!

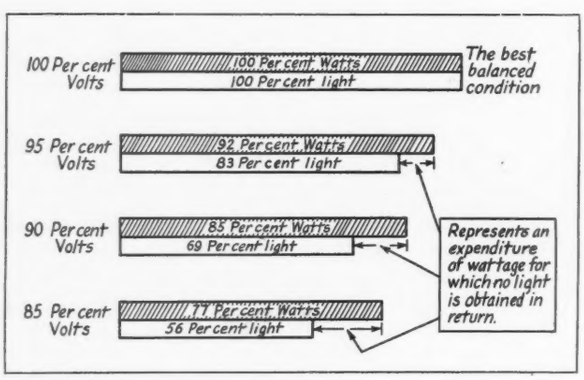
In view of the trend of modern lighting, it is a gross mistake and needless expense to wire a building for only the minimum requirements. Adequate wiring will permit a storage area to be utilized at some future time for a production area where close visual application or speed of vision necessitates better lighting. During the time when the area is used for storage, low-wattage lamps can be used; when detailed work is performed in that same area, the mere substitution of larger lamps will be all that is necessary if the wiring is adequate. If the wiring is originally installed to serve only the minimum for a storage area, larger lamps cannot be substituted without overloading the circuits and a greater expense is necessary for rewiring if good lighting is to be provided.

It is advocated that the wiring installations have sufficient capacity to serve at least double the wattage used at the present time. This practice will increase the wiring cost from 20 to 30 per cent, and without doubt save a much greater expense a few years hence when the demands of factory operation are greater. A chart is included to show how the installation cost

Before this plant was re-wired 100-watt lamps were employed, which accounts for the low level of illumination.

varies with the wattage per outlet. The increased wiring capacity will permit the relocation of various operations, or the leasing of the building to a manufacturer whose requirements are entirely different from those of the present occupant. Where only a low level of illumination is necessary, low-wattage lamps can be used in the same circuits that will permit higher-wattage lamps when more light is desired. The flexibility of such an arrangement will be a distinct asset to the building as well as to the organization occupying it. The investment in additional capacity for wiring system is inexpensive insurance against the obsolescence of the entire system when installed according to minimum standards.

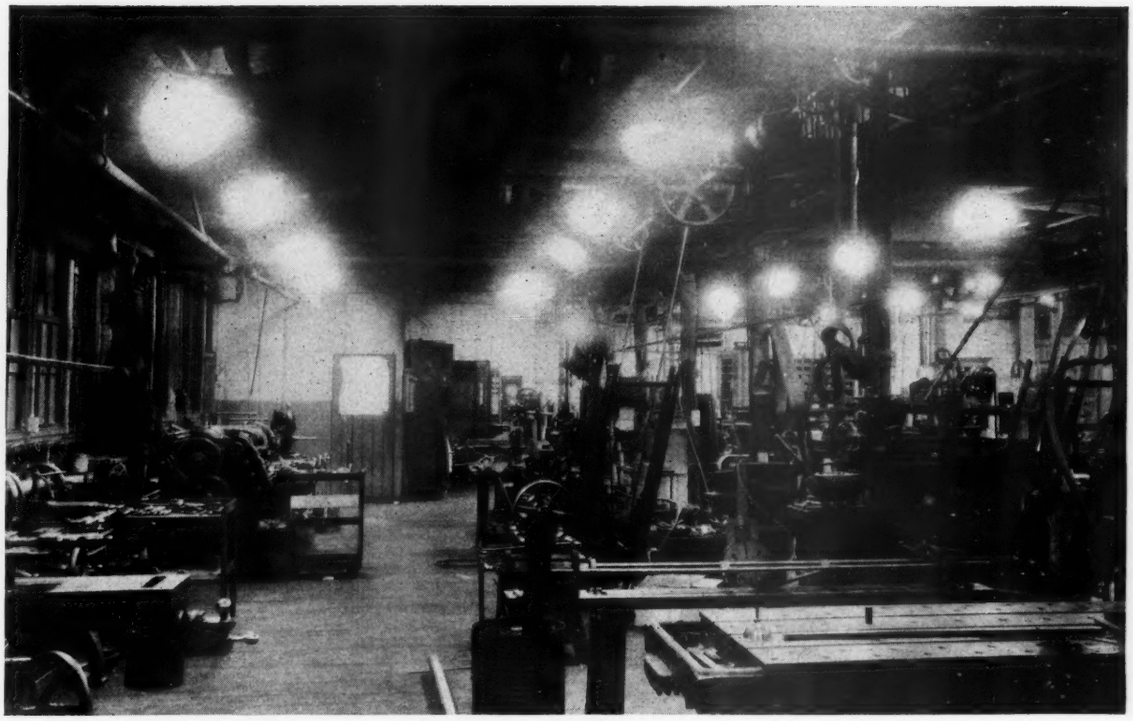
Incandescent lamps are designed to provide a definite amount of light, and to burn an average of 1,000 hours when operated at the rated voltage specified on the lamp. If the lamp is operated on a circuit which is overloaded, the voltage drops and the light output of the lamp will be decreased. The life of the lamp will be prolonged and the current consumed will be somewhat less which would lead one to believe that the operation of lamps under their rated voltage would result in a saving. However, this is not true, since the loss in light outweighs any saving in the cost of lamps and electric energy. Accompanying illustrations show graphically what happens when lamps are operated at other than rated voltage, and when the wiring is inadequate. It must always be remembered that lamps and the energy to operate them are bought with the purpose of providing illumination only. Therefore, we should consider the cost of light as produced by lamps operating under normal voltage conditions as compared to their operation under subnormal voltage.


100 Per cent Volts
100 Per cent Watts
100 Per cent light
The best balanced condition
95 Per cent Volts
92 Per cent Watts
83 Per cent light
90 Per cent Volts
85 Per cent Watts
69 Per cent light
85 Per cent Volts
77 Per cent Watts
56 Per cent light
Represents an expenditure of wattage for which no light is obtained in return.

Graphical comparison to show loss of light when lamps operate under rated voltage.

An interesting study bringing out this point was made by the lighting service committee of the National Electric Light Association. To get the average costs on wiring, plans of a building with six different wiring specifications on each plan were sent out to electrical contractors in five different cities. From the replies estimates of the cost of adequate wiring to provide for future increases, and also the cost of inadequate wiring were obtained. From the data submitted, the losses resulting from the use of 300-watt lamps on circuits designed for only 150-watt lamps were calculated.

The wiring plan consisted of 96 outlets. With these outlets adequately wired to permit the operation of 300-watt lamps without excessive voltage drop or heat loss, the cost of energy to operate all of the lamps 1,500 hr. per year at 5c a kw.-hr. would amount to $2,160. The lamp cost for the year was calculated to be $136.80. The loss in overcoming the resistance of the wire was figured at $28.46, which brought the total annual operating cost of the lighting system to $2,325.26. For a total of 763 million lumen hours, the cost of light would average $3.05 per million lumen hours.



The same plant, but after rewiring for 300-watt lamps to provide an illumination level of 18 foot-candles.

With the same size lamps operating on circuits designed for 150-watt units the lamps would operate 2.5 volts below their rated voltage (115 volts). Under this condition the lamps would consume 96.6 per cent of the normal wattage and the life would be increased 33 1-3 per cent, but the light output would be only 83 per cent of normal. Operating the same number of hours and at the same rate for current, the annual cost in this case would be $2,088. The cost of the lamps would be reduced to $102.62, and the loss in overcoming resistance would amount to $76.52. There would be a total operating cost of $2,270.74 for 710 million lumen hours of light obtained.

Comparing these costs, a saving of $55.52 in operating cost is shown, but with a loss of 53 million lumen hours of light. At $3.05 per million lumen hours, this loss would amount to $161.65 annually, and after deducting the saving of $55.52 there would be a net loss of $106.13 owing to inadequate wiring.

The cost of installing adequate wiring was shown to be $236 more than for the wiring system which would meet only the minimum requirements. This small added investment would save $106.13 annually when using the higher-wattage lamps. In other words, it would take slightly more than two years to make up the difference in cost to wire the building to insure against loss when the standard of illumination is increased.

The conditions shown in photos above are typical of what is happening in an increasing number of plants. The original installation employed 100-watt lamps in each outlet. Inadequate wiring necessitated the rewiring of the entire plant in order to provide illumination of modern standards. Lamps of 300-watt size are now used where the 100-watt sizes were used before; however, the new wiring is sufficient to permit the use of 500-watt lamps should it be desired to again increase the level of illumination at some future time.

When wiring a new building or rewiring an old one, it should be remembered that the requirements of the National Electrical Code or local municipal codes do not attempt to define preferred practice. They define only safe practice. The following specifications prepared by the Lighting Bureau of the National Electric Light Association are in addition to the minimum national and local regulations and assure adequate wiring rather than minimum.

Branch Circuits—In no case shall one branch circuit for overhead lighting supply the lighting for work space or rentable area greater than 400 sq. ft. or a bay approximately 20x20 ft., nor shall one branch circuit for overhead lighting supply more than 800 sq. ft. of hall or passageway or other non-rentable or non-productive area.

Based on the wattage of outlets specified on the plans, branch circuits shall be so arranged that the load on a circuit shall in no case exceed 1,000 watts, except in the case of a single lamp of larger size.

Not less than No. 12 B&S gage wire shall be used, either for runs from panel board to the first outlet, or for runs between outlets. For runs of 50 to 100 ft. from the panel board to the first outlet, not less than No. 10B&S gage wire shall be used, and not less than No. 12 between outlets.

Runs exceeding 100 ft., from the panel board to the first outlet, should be avoided wherever possible by the addition or relocation of panel boards. Where such runs cannot be avoided, the initial lamp load as indicated on the plans shall be limited to 600 watts for each circuit, and wire not smaller than No. 10B&S gage shall be used between the panel board and the first outlet.

Convenience outlets shall not be placed on any circuit supplying ceiling-lighting outlets. Wall and baseboard convenience outlets, except as otherwise noted, shall be of the du-

(Please turn to Page 534)

To drive these hydraulic pumps—

ONE MOTOR *or* SIX?

By J. GORDON FLETCHER
Assistant Superintendent
John T. Lewis & Company
Philadelphia, Pa.

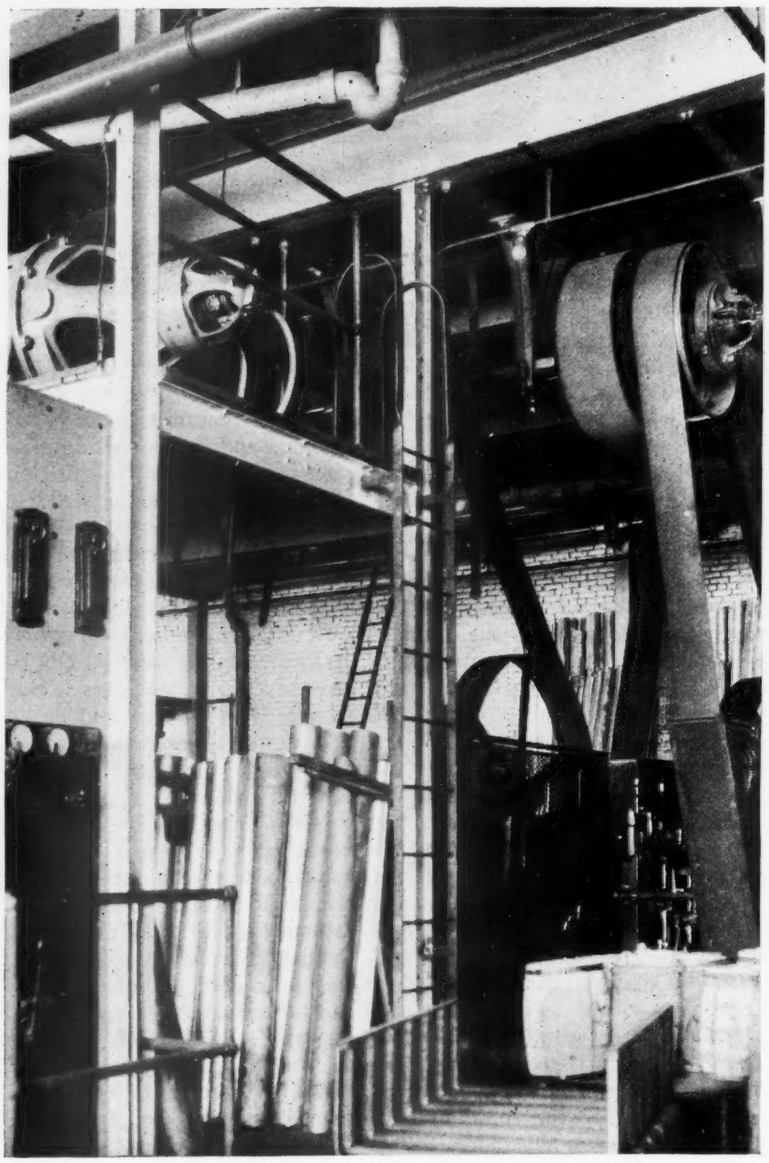
EACH mechanical power transmission line, as a general rule, presents features of design peculiar to itself. In some plants, where groups of machines of similar type and size are used, it is possible to develop a standard drive that best fulfills the requirements.

Where the machinery is of diversified nature and size the problem of drive design becomes more involved. In an old plant, for example, that has gradually grown through a period of years, an answer to the question of how to take care of additional equipment is continually being sought. In such a case the usual procedure is to follow the type of drive used before, and the transmission engineer is most likely to be told that the old drive is serving so well that no change is desirable.

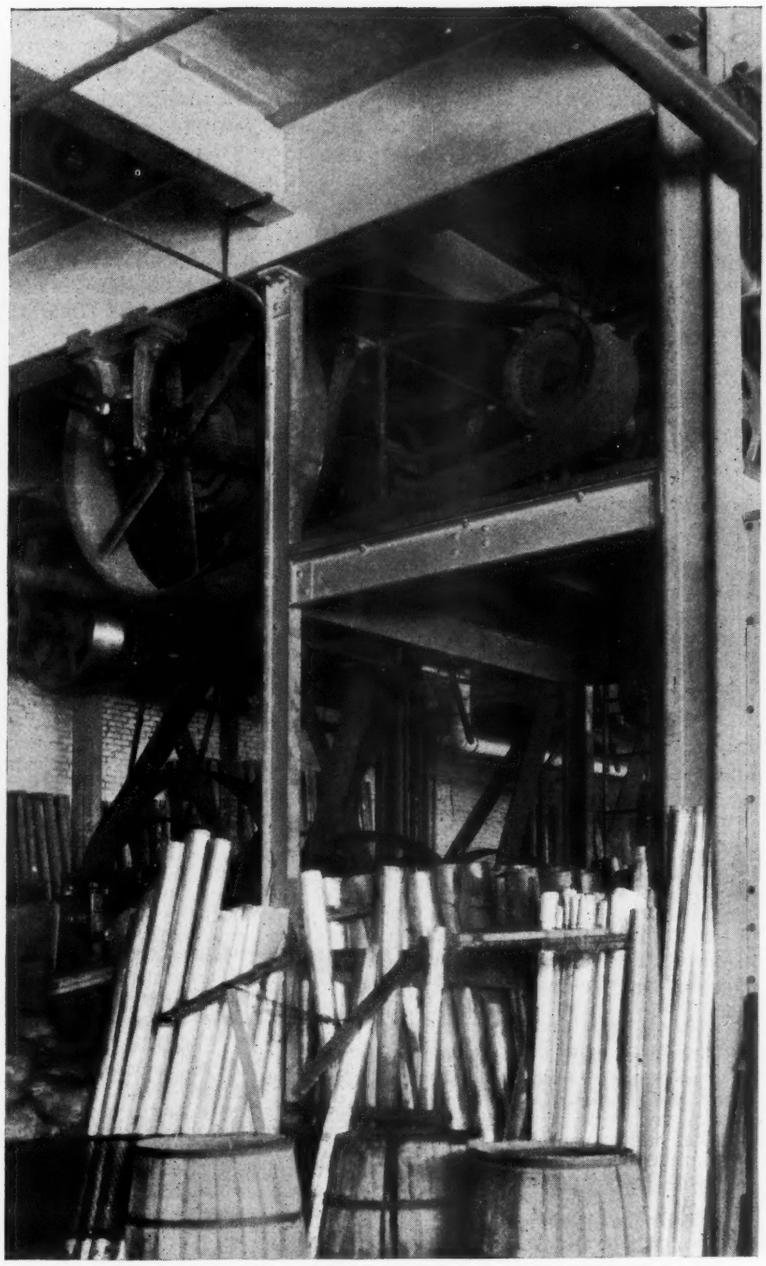
Like most of the problems of business, the choice of the proper type of drive depends upon the economics of the situation, and it is possible to predetermine which type offers the best financial return. Unfortunately, the men who are responsible for the selection of transmission machinery sometimes lack the technical training necessary for that task. They may either adopt one type of drive and standardize on it, regardless of its economic value, or, under the influence of high-pressure salesmanship, purchase something not at all suited to their needs.

A recent problem gave an opportunity to weigh the various points involved in choosing between group and individual drives. A new manufacturing plant was being erected, and it was necessary to design the drives for six high-pressure hydraulic pumps grouped closely together, each one supplying a separate press with no intercommunication between the pressure lines. It was agreed by everyone concerned that their choice would be that drive showing the lowest cost per unit of production with depreciation, interest, and operating expenses taken into consideration.

At first individual drives were favored for these pumps because it seemed that there was something to be gained in the way of operating convenience through the use of push-button motor control, and because repairs would be possible without



Arrangement of lineshaft drive for six high-pressure hydraulic pumps. A synchronous motor rated at 75 hp., 900 r.p.m. is used. The reduction ratio of 9:1 gives a speed of 100 r.p.m. for the pump shaft.



Another view from the pulley end of the motor. A friction clutch for each pump permits all or any desired combination to be operated at any time.

An analysis of the problem of driving a battery of hydraulic pumps, and how it was solved

danger to the operator, regardless of how many of the other pumps were running.

In studying the layout from the standpoint of using individual drives it appeared possible, because the entire installation was new, to secure rigid concrete foundations for both pumps and motors. As the motors would be on the floor and operating on short sprocket centers, chain lubrication could be readily taken care of, as any oil leaking from the chain housings would run directly to the sewer. Overhead motor drive was not feasible because the high ceiling would call for very long chains, at a prohibitive cost.

The pump manufacturer specified that with individual chain drive each pump must be provided with a 25-hp. motor. The press operating cycle involved a period of no load while the cylinder was being charged, followed by a run at full load during the time when pressure was being applied. The pump ran constantly although the interval of no load was longer than that of full load, thus producing a most irregular motor-load cycle. Finally, the nature of the business might necessitate shutting down a press for considerable periods, with consequent loss due to idle investment.

For six pumps with individual drive there would have been an installation of 150 hp. in induction motors operating at a power factor hardly likely to exceed 80 per cent at maximum demand, with a combined average power factor more likely to run below 60 per cent. Inasmuch as these motors were less than 50 hp. in rating they would have been designed for low voltage, which in turn would have necessitated the purchase of additional transformer capacity.

A better understanding of the power requirements was secured through a graphic wattmeter test on a similar installation of four pumps. In this case a 50-hp. motor was belted to a lineshaft from which each pump was driven by a separate belt. The power test showed conclusively that it was possible to operate four pumps simultaneously without causing any undue heating of the motor, and the drive was giving complete satisfaction.

Using this test as a basis, a drive for the six pumps was then designed, calling for a 75-hp. synchronous motor of the unity power factor type operating at 2,300 volts and driving the pumps through a lineshaft by means of separate belts and friction clutches. It was realized that the use of a 2,300-volt motor would entail a slightly higher cost for the necessary auxiliary equipment, but would save a considerable sum through the elimination of additional transformers, which in turn would improve the power factor.

The reason for using a synchronous motor may be briefly explained as follows:

In an alternating-current circuit the voltage and current are changing

from zero to maximum in one direction, and then in the reverse direction 60 times a second. As a result of these oscillations, counter-electromagnetic forces are set up that throw the voltage and current out of phase with each other. The power consumed in such a circuit is equal to the product of volts times amperes times the cosine of the angle of phase displacement. Heating of the conductors is proportional to the current squared, so that for a given amount of power with the voltage remaining constant the current increases as the power factor, or cosine of the angle of displacement between current and voltage decreases.

Because of the increased current flow and heating at low power factors, without any increase in useful work done, most public utility companies impose a penalty for power factors below 90 per cent.

Induction motors cause lagging currents and low power factor, whereas synchronous motors, which have a separately-excited field, draw a leading current which greatly improves the power factor. At the same time the machine does useful work, like any other motor. These motors can be designed to operate at unity power factor, or at 80 per cent power factor, depending on how much correction is needed in a circuit.

Comparative cost estimates showed that the single motor drive with belts could be installed for considerably less than the individual motor drives, and the power factor could be raised above 90 per cent and held there regardless of the load demand. Inasmuch as the pump load cycles would not coincide, it was safe to assume a fairly uniform motor load with high power factor. With power purchased on the basis of a penalty for power factors below 90 per cent, it was estimated that there would be a saving of probably 20 per cent or more on the kilowatt-hour charge, as compared with individual induction motor drive.

Study of the space available showed that there was ample headroom to permit the installation of shafting with sufficient distance between pulley centers. The use of belts would cause no loss in illumination, whereas the air circulation set up by the belts would probably prove beneficial. The use of shafting hung overhead would release for storage valuable floor space which otherwise would be occupied by individual motors.

To safeguard the operator while making repairs a substantial friction clutch was provided on each pump drive. With all of the large pump pulleys connected through belts to one lineshaft, a considerable flywheel effect would be provided to smooth out the sudden fluctuations in pump loads, thus improving motor operation.

From experience gained in operating many drives over a number of years it seemed safe to assume that good leather belts, properly taken care of, would have as long a life as other drive mediums, with no higher maintenance costs. In addition, the belt drive, with its lower first cost, would carry a smaller interest and depreciation charge.

It is seldom that snap judgment or non-technical salesmanship will indicate the correct type of drive to be used. If, through careless engineering, the essentials necessary for proper installation are overlooked, considerable expense may be entailed.

One Plant Engineer's Duties

ORGANIZATION and management of service departments in a large plant with over 6,000 employees, doing a great variety of unstandardized work of fluctuating volume, and spread over an area of 140 acres, present many difficult and complicated problems in comparison with similar problems in the usual manufacturing establishment.

The following, an excerpt from a paper by W. B. Ferguson and Tom H. Blair, outlines the duties of the plant engineer in such a plant—the Newport News Shipbuilding and Dry Dock Company. The paper was presented before the Management Division of the American Society of Mechanical Engineers.

Duties of the Plant Engineer

The plant engineer is responsible to the management for providing suitable buildings and equipment for carrying on the productive work of the plant in an economical and expeditious manner. It is his duty to advise with the various department heads and investigate any requests for new equipment or buildings, changes in locations of present equipment or alterations in the design to increase efficiency, and to design any needed special equipment which cannot be obtained from the usual sources. This work is organized under the following headings:

1. Office Staff
2. Buildings and Structures Section
3. Machinery-Design Section
4. Small-Tools Section
5. Electrical Section

1. The Office Staff, in addition to other duties, keeps records by numbers and locations of all numbered machines and other equipment throughout the various departments. This section also takes the monthly readings of all meters measuring electric current, gas, and water purchased and of such other meters as are installed to record the electric current, gas, and steam used in various parts of the works.

2. The Buildings and Structures Section is in charge of a structural designer who is capable of designing buildings, cranes, crane runways, etc., and of advising the overload carrying capacity, if any, of any bridge crane, jib crane, or building structure in the yard. Also, in this section, there is a building inspector whose duty it is to inspect all buildings, estimate cost of repairs or proposed changes in the arrangement of buildings or their equipment and to see that repairs and changes are carried out in a satisfactory and workmanlike manner.

3. The Machine-design Section is in charge of a machinery designer who is capable of designing special equipment and advising as to the overload capacity of existing equipment. This section also has charge of the design of special tools, jigs, and fixtures required for unusual jobs.

4. The Small-Tools Section is in charge of a small-tools inspector who has charge of the inventory of small tools, the interdepartmental transfer of small tools, tests, and standardization of small tools. This inspector's duties also include the inspection of all requisitions for small tools to be sure that only those that are standard will be ordered.

5. The Electric Section is in charge of a designer who is capable of designing, laying out and ordering switchboards, control equipment, and motors, and of determining wire sizes, etc., for power transmission.

Emergency machinery repairs amounting to $50.00 or less are taken care of by the repair department directly, all charges being made directly against the machine number. For major repairs or general overhauls, the work is covered by a foreman's repair order which is submitted to the plant engineer who issues a repair job order covering the work. In this way the charges are segregated so that in some cases, when so authorized, the departmental budgets may be relieved of unusual special expenses for which they cannot be held strictly responsible.

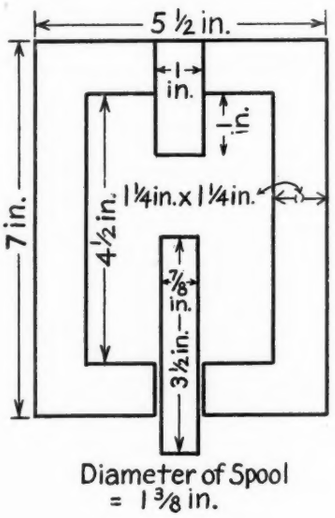
Upon requests from department heads, the plant engineer issues all special equipment order to cover machines, tools, jigs, and fixtures which are purchased or manufactured to execute particular jobs or contracts. Upon completion of the work these special equipment orders are closed and final returns are available for the inspection of those interested.

The plant engineer shall also be responsible for all costs for new small tools charged in Asset Account 6 and for the quantities of such tools acquired either by purchase or by being manufactured in the yard.

QUESTIONS *and* ANSWERS BY READERS

Winding for A.C. Electromagnet

I have an electromagnet frame of the dimensions shown in the diagram, but do not know what the winding data were. I shall be grateful if some fellow reader will let me know the size of wire and number of turns to use on



this magnet so that it will develop the maximum pull on a 110-volt, 60-cycle circuit.

H. J. F.

Ottawa Ontario, Canada.

Why Do These Belts Slip?

Considerable trouble is being experienced with the belts used on some across-the-line motors of 1- to 5-hp. rating. Heretofore we have had little real trouble with our belts. No change in quality has been made, so far as we know, but they do not seem to start the load so well with the new motors; after the motor is up to speed the belts apparently carry the load satisfactorily. Frequently a belt slips off when the motor is started. In practically all cases there is excessive slipping and squealing at the start. Two or three times the motor pulley has simply spun around and burnt the belt seriously. Belt dressing does not seem to help much. I shall appreciate it if readers will give me some suggestions on the cause of this trouble, and how to cure it. Is it likely to be due to a poor grade of belt?

Minneapolis, Minn. **G. McC.**

Chain Length Determination

Several years ago our plant was thoroughly modernized, overhead shafting was reduced to a minimum, drive centers were shortened, chain was used as the drive medium between the motor and the countershaft, but belts were retained to provide a flexible connection between the countershaft and the machines.

Outside of ordinary repairs we have had no trouble with the chain drive, but it is time to consider replacing several that are in continuous service. From one angle I am told that the ordinary formula for chain length is used to determine the length, and from another, various values must be used in conjunction with the formula. Are these values then, standard for all chains or are they set up by the various manufacturers for their particular type of chain? How then, is the length of chain determined for a drive having sprockets with 19 and 75 teeth, a 42-in. center distance, and ⅞-in. pitch?

Cleveland, Ohio. **R. V. L.**

ANSWERING R. V. L., the ordinary equation is used to obtain the length of chain for any drive, given the number of teeth in the sprockets, the center distance, and the pitch of the chains. However, as this method is rather tedious to apply, the manufacturers of such chains have worked it out in simpler form by using a table of constants based on the angle between the two strands of the chain and the effect of the center distance.

Taking R. V. L.'s case for an example the calculation would be as follows:

L=length of chain in pitches
T_1 and T_2=number of teeth in sprockets
C=center distance divided by pitch
K=a constant based on the difference between the number of teeth in the sprockets, in this case 56.

Then $L=[(T_1+T_2)\div 2]+2C+(K\div C)$.
Substituting the known values we have
$L=(94\div 2)+(2\times 48)+(79.44\div 48)$
Solving,
L=144.655 pitches.

Taking the next even number, or 146, and multiplying by his pitch of ⅞ in., gives a chain length of 127¾ in. I am inclined to think that his pitch is really 0.9 in., instead of ⅞ in. as I have been unable to find such a pitch in my catalogs, although I have a rather complete file. If this is the case R. V. L. can find the information he desires on page 9 of the Morse Chain Company Data Book.

Mexico, Ky. R. R. SCHELLENGER.

Increasing Speed of Spot-Welding Operation

Will someone tell me how long it should take a 15-kw. spot welder to weld a piece of 12-gage sheet iron to a strip of 3/16-in. iron, when it is operating properly? This is one of our operations at the present time, but if we use sufficient current to make the weld in less than ten seconds it will burn a hole in the 12-gage sheet. On the other hand, allowing ten seconds or more for each weld slows up our process too much. I shall appreciate any help you can give me on the possible cause of our trouble and how it can be remedied.

Peoria, Ill. **J. R. H.**

WITH reference to J. R. H.'s question, there are a number of conditions other than the proper operation of the machine that enter into such a problem. Among these are the diameter of die points used, the secondary or welding voltage, type of machine, and so on.

However, assuming that a pedestal type of foot-operated machine is used with, say, a 12-in. horn, and that the work does not extend very far into the horn, I would say that No. 12 gage sheet iron could be welded to 3/16-in. strip iron in approximately three seconds. This estimate is based on the assumption that the material is reasonably clean; that is, does not have too thick a coating of scale or rust. It is also based on our standards as to the secondary or welding voltage on a 15-kw. or 20-kva. machine.

It is my opinion that one of the reasons for the burning mentioned is lack of pressure on the welding electrodes. The pressure on the electrodes for welding the thicknesses of material given should be from 300 to 350 lb.

when using die points approximately 5/16 in. in diameter. Die points ½ in. in diameter would require considerably more pressure.

I would suggest that J. R. H. use a die point rounded on the end in much the same manner that a capscrew is rounded, as this is the best type of point for universal use. Also, he should apply as much pressure as it is possible to obtain on the welding electrodes. If he will do this I believe that he will be able to step up the current to a point where he should be able to make a weld in approximately three seconds without burning the work.

W. M. PRICE.

W. Montelius Price Company,
Seattle, Wash.

Location of Idler Pulleys

We have several old air compressors driven by 25- to 50-hp. motors through leather belts. The motors and compressors are mounted on a common foundation, the distance between the shafts ranging from 8 ft. to 12 ft. The compressors are equipped with an idler pulley. In one case the idler is about the middle of the belt and in the other drives it is about two thirds of the distance between the compressor and motor, being closer to the motor. The compressors are running at full load or more and the belts are giving trouble from slippage and wear. Increasing the weight of the idler does not help much and I think the idlers should be placed closer to the motor pulleys, but do not know how much closer to place them. Is there any formula or rule that I can use to locate these idlers the proper distance from the motor pulley?

Cincinnati, Ohio. **J. C. D.**

IN reply to J. C. D., idler pulleys are frequently located one-quarter of the distance between shaft centers, toward the driving shaft. However, I have seen drives where this rule was violated with no noticeable bad effects. For this reason I suspect that all is not well with the belt itself; either it is too light for the drive or it requires an occasional application of a good belt softener. An anti-slip compound, commonly called "stickum," in shop jargon, should never be used, as it will tend to dry out and stiffen the belt, whereas the opposite condition is desired.

A compressor drive taxes a belt severely, due to the constant and rapid fluctuations in the load. A belt for a machine of this type should be pliable enough to wrap easily around the pulley, and elastic enough to "give and take" with the load fluctuations.

In the design of any belt drive, a number of factors must be considered. As these factors vary in each case, the solution must also vary. In complying with any of the requirements of a belt drive, care must be taken to avoid embodying any features which may be injurious to the belt. In my opinion, the practice of installing an idler pulley close to the smaller pulley of the drive shortens the life of the belt, first, because it produces two short bends in the belt, and second, these bends take place with a very short time interval between the two.

Heat is generated by the flexing of a belt, due to the internal friction; the degree of heat generated depends upon the extent of the flexures and the rapidity with which they take place. With the idler located as I have stated, the flexures are not so pronounced and there is a greater time interval between the two flexures, so that a cooler running belt will result. It is true that a closely-placed idler will increase the arc of contact, but with the idler located one-quarter of the distance between shaft centers, a contact of at least 180 deg. can always be secured.

Master Mechanic, R. H. KASPER.
Steel Heddle Manufacturing Company,
Philadelphia, Pa.

Effect of Low Voltage on D.C. Motors

I wish some reader would tell me how th evoltage drop in a power line affects the power developed by a d.c. motor. For example, we have a 10-hp., 230-volt, 1,750-r.p.m., compound, ball-bearing motor installed in a mine about 1½ miles from the power supply. The full-load current of the motor is 39 amp. Under a recent test the motor drew 40 amp. at 150 volts. What power was developed by the motor? With normal voltage a 5-hp. motor would be large enough to handle the load. Under our conditions would it be advisable to use a smaller motor?

St. Louis, Mo. **C. O. L.**

ANSWERING C. O. L., the torque developed by a d.c. motor is directly proportional to the product of the armature current and the field flux. When the armature current is maintained at a constant value the torque developed will vary with the field strength, which in the case of a shunt motor varies directly as the voltage impressed on the field winding. However, in the case of a compound-wound motor the field flux does not vary in direct proportion to the field voltage.

Considering the motor in question, a reduction in the terminal voltage from 230 to 150 volts will result in a decrease in field strength of approximately 26 per cent with a corresponding reduction in torque. The horsepower output of the motor is given by the following equation:

Horsepower = Torque x r.p.m. ÷ 5,250

Providing the speed remained constant, the power developed by the motor would be about 7½ hp., with the motor taking 40 amp. at 150 volts. However, the reduction in voltage also produces a reduction in speed, which in this case would amount to about 300 r.p.m., giving an operating speed of 1,450 r.p.m. The power developed under these conditions would be 6¼ hp., roughly.

If a speed of 1,750 r.p.m. is desired, and if the load is one requiring a constant torque, the motor will have to deliver about 7½ hp. at that speed. In the event that this is a fan drive where the power required increases approximately as the cube of the speed, the load on this motor would then be 11 hp., approximately.

Chief Engineer, S. S. WOLFF.
American Electric Motor Company,
Cedarburg, Wis.

High Voltage to Ground From Underground Transformers

I have two 5-hp., three-phase, 220-volt, 60-cycle induction motors located about ½ mile apart that are fed from two 2,400/240-volt transformers connected in open delta and not grounded. Both motors became grounded and in testing with a voltmeter of 0-300 scale I found that the voltage on the line side of the safety switch for each motor registered 240 volts, across all lines. When I tested from the ungrounded line to ground, with the motors running, the voltmeter was thrown off the scale every time. I should like to know what caused this action and how to prevent this high voltage to ground.

Reidsville, N. C. **G. D. C.**

ALTHOUGH G. D. C. states that the line voltage is 240 volts across all lines, a careful check should again be made of these voltages. If the transformers have by any chance been wrongly connected, it would be possible to obtain as high as 416 volts between two of the lines. With the proper conductor grounded, this voltage could be obtained to ground, which, of course, would throw the 300-volt meter off scale.

It is possible, of course, to have a cross connection between the 2,400-volt and 240-volt windings, but this condition would give more than 2,000 volts to ground, which in itself would probably cause a failure in the motor or in some portion of the wiring or the control equipment.

It is recommended, therefore, that G. D. C. check the individual voltages of the transformers and then the voltage between the two lines which are taken straight out of the transformers and are not common or tied together through the shaft centers of the two to make the third line. Even though the transformer bank may be wrongly connected, a motor will operate under these conditions, although the voltages would be 240, 240 and 416 volts. Tests should be made from all lines to ground.

C. O. VON DANNENBERG.

New York, N. Y.

Metering Three-Phase Four-Wire Secondary Systems

WITH the development and increasing use of three-phase, four-wire secondary distribution systems, a number of important problems and questions have arisen. In Publication No. 267-53 there are presented, in the form of a serial report of the meter committee of the National Electric Light Association, the results of a thorough investigation of the various methods now in use and the types of instruments available for metering such systems.

Theoretically, it is possible to meter the energy in any circuit by using one meter less than there are lines in the circuit. This theoretical condition is known as Blondell's theorem, and practically is often called the N-1 watt-hour meter rule.

According to the N-1 rule a three-element watt-hour meter is required to measure a three-phase, four-wire service. Under this method it is understood, of course, that the potential coils of each element are connected from their respective phase wires to the neutral wire. This method, shown in Fig. 1, of measuring three-phase four-wire circuits is correct for unbalance in either load or voltage.

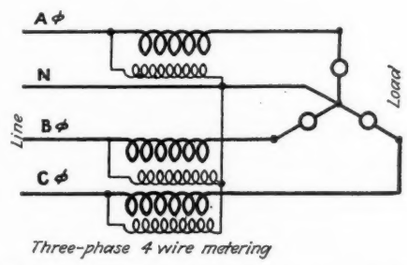


Fig. 1—Connections for metering a three-phase, four-wire installation with a three-element watt-hour meter.

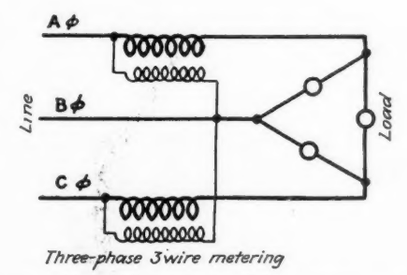


Fig. 2—Metering polyphase power load with a two-element polyphase watt-hour meter.

Where the power and light loads are separated, the polyphase power load is metered three-phase, and requires only the two-element polyphase meter, as shown in Fig. 2.

Where two-phase wires and a neutral wire are used for small, single-phase power loads at 208 volts, and for three-wire lighting loads at 120 volts, a special problem of metering is presented (Fig. 3). Owing to the phase relations of current and voltage in the two phases and the neutral, the ordinary three-wire meter used to measure three-wire, single-phase circuits will not suffice. The two-element polyphase meter may be used, however, to meter the installation accurately.

From the above it is evident that three-phase, four-wire energy measurements necessitate the use of three different types of metering, as follows:

1. Three-phase, four-wire metering.

2. Three-phase, three-wire metering.

3. The metering of a circuit consisting of two-phase wires and a neutral wire from a three-phase, four-wire source.

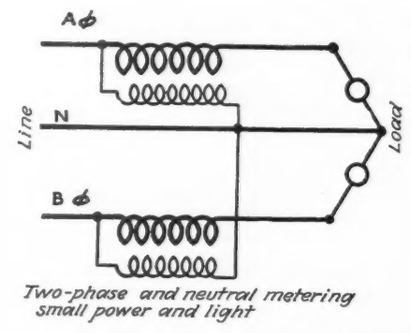


Fig. 3—Metering three-wire lighting loads at 120 volts, and single-phase power loads at 208 volts, with a two-element polyphase watt-hour meter.

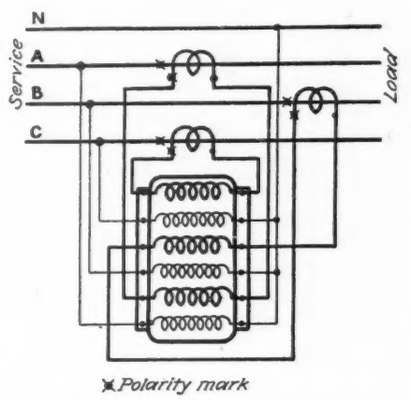


Fig. 4—Diagram of connections for metering a three-phase four-wire installation with a three-element meter.

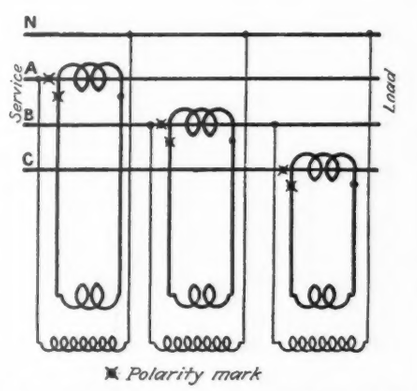


Fig. 5—Diagram of connections for metering a three-phase, four-wire installation with three single-phase meters.

At present there are available a number of methods for measuring three-phase, four wire energy, among them being:

(*A*) Metering with a three-element polyphase meter. Fig. 4 shows the connections of the three-element meter.

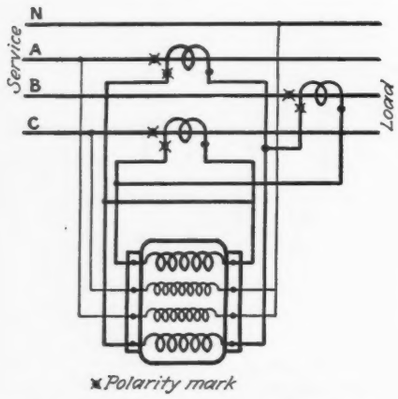


Fig. 6—Connections for metering a three-phase, four-wire installation with a two-element polyphase watthour meter using three current transformers connected in delta.

(*B*) Metering with three single-phase meters (Fig. 5).

(*C*) Metering with a standard two-element polyphase meter (two potential coils and two current coils). This method necessitates the use of three current transformers connected in delta (Fig. 6).

(*D*) Metering with a three-phase, four-wire, two-element meter equipped with split current coils (Fig. 7).

The methods listed under items (*A*) and (*B*) above are considered the most desirable, as they are accurate under all load conditions. The methods listed under items (*C*) and (*D*) are not accurate on unbalanced voltages. However, these last two methods are capable of equally high accuracies under balanced voltage conditions and, since less costly, are frequently used.

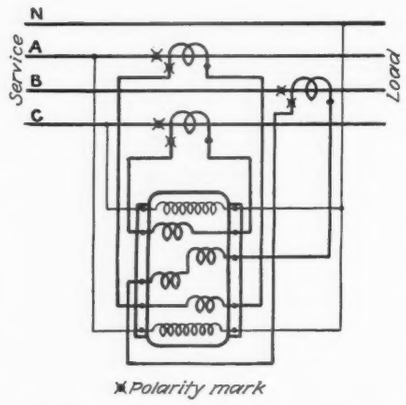


Fig. 7—Metering connection of a three-phase, four-wire installation with a two-element polyphase watthour meter equipped with split current coils.

A circuit consisting of two-phase wires and a neutral wire from a three-phase, four-wire source (mentioned under item (*2*) can be measured by the two-element polyphase meter, an alternative being the use of two single-phase meters.

In order to meter such an installation more economically at least one special meter is being developed by a meter manufacturer. This meter is of more simple design than the standard polyphase type and, therefore, is not so costly. This meter is said by the manufacturers to be correct regardless of unbalance in current or voltage.

From both a metering and an economic viewpoint, the practice of metering both power and light on one meter is advantageous. However, it is often desirable to separate the two consumptions (power and light) for billing purposes, and this may be the controlling factor. Thus the decision of whether to meter power and light installations with one or two meters becomes one for local solution.

Another factor, upon which is based the type of installation selected, is the demand registration. The graphic or indicating demand can be procured by the two-element polyphase meter with the limitations of method *C*. The three-element meter is adapted for graphic or indicating measurement.

A Memorial to George Westinghouse

A MEMORIAL to George Westinghouse, erected by those who were associated with him and by the 60,000 employees of the industries he founded, was erected in Schenley Park, Pittsburgh, Pa., early in October.

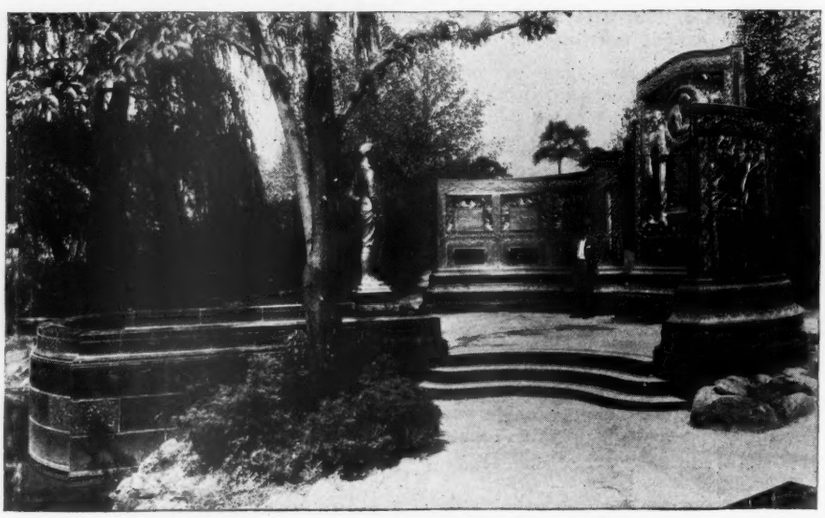
Over 400 inventions were patented by Mr. Westinghouse, chief among them being the air brake, and railroad switching and signaling systems. He founded scores of successful companies and directed many engineering undertakings.

E. M. Herr, vice chairman of the board of directors of the Westinghouse Electric & Manufacturing Company, presided. The program included addresses by A. L. Humphrey, president of the Westinghouse Air Brake Company, Charles H. Kline, mayor of Pittsburgh, and others of national industrial and political importance.

The monument itself is in four sections and stands upon a base of Norwegian granite. Its principal component consists of a large central panel flanked by two semicircular wings. A figure of the American Boy stands well away facing this group.

The central panel carries a medallion of George Westinghouse supported on either side by a figure of a skilled mechanic and an engineer.

Each of the flanking wings is divided into three panels and on each panel is depicted one of Mr. Westinghouse's achievements.



AN ECONOMICAL COMBINATION WATER SYSTEM

By O. P. WILLMS
Consulting Engineer
Milwaukee, Wis.

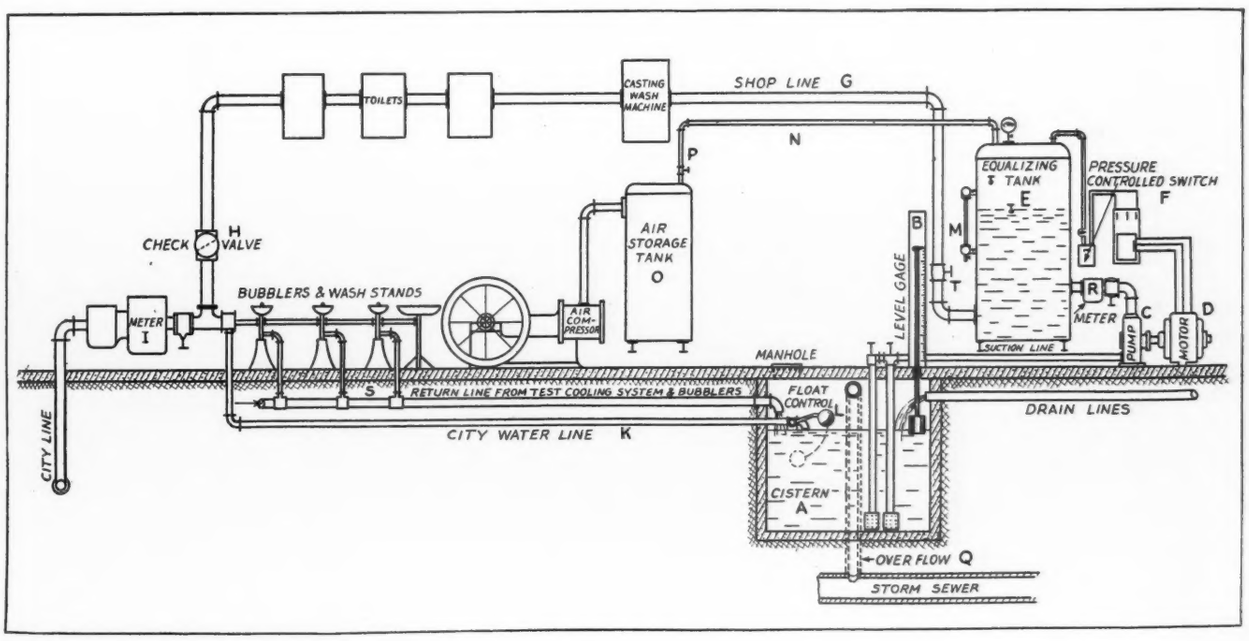
WHEN I was confronted with the problem of building and equipping a large addition to a local plant manufacturing gas engines, I noted soon after starting the grading work that I was to build on a territory which was badly infested by springs. The nearest manufacturing plant, south of us, a foundry, got all its water out of a spring, while another plant, east of us, had had the sad experience that the spring water lifted a 15,000-gal. gas tank clear out of the ground. My foundation ditches filled up with water to the brim every night, and on one place I had to divert a lively stream in another direction in order to be able to lay my foundations.

As the nature of the product of the plant demanded a heavy use of water, and the city charge was fairly high, with a 50 per cent rise in prospect, I suggested to the management to make use of that springwater by draining it into a cistern and pumping it into the factory independent of the city water, which would still have to be on hand for drinking and washing purposes. After the firm consented to my plan, I laid out an elaborate draining system around and partly through the plant and along our spur track, which ran into the factory's shipping department.

This drainage system relieved the track and concrete floor from the danger of underwashing and salvaged a large amount of water for toilets, wash-machines, and general cleaning purposes. While the laying of the drain lines and the building in general was in progress, I conceived the idea of combining the two water systems in such a way that the city system would automatically replace or support my private system, in case the latter would fail for one reason or other, and I succeeded in creating a combination as shown in the accompanying sketch.

All drain lines and returns from drinking fountains and test cooling systems lead into cistern *A*, which is equipped with a simple level gage *B*, indicating the height of the water level. This cistern is located in a quiet corner of the shop and holds about 10,000 gal. of water. A pump, *C*, driven by electric motor *D*, pumps the water into an equalizing tank, *E*. The suction line is split into two full-size lines, each equipped with shut-off valve and strainer head, so that in case of clogging of one strainer that individual line can be shut off and the other line opened while cleaning the clogged one.

The motor is controlled by a pressure control, *F*, which is set for cutting in at about 5 lb. below city pressure and out at about 10 lb. above. This control is easily adjustable and I found it very reliable. *G* is the main line, leading into the shop to the toilets, casting-wash machines, etc., and connects directly on to the top of the check valve *H* which, on the bottom side, connects the city water meter *I*. Between check valve and



Profile sketch of the combination water system designed and built by the author.

meter is a connection for a line leading to drinking fountains, washstands, and kitchen, where city water only can be used, and another line, *K*, which runs to the cistern and is controlled by a float valve, *L*. Line *K* opens up and lets city water into the cistern when, in case of heavy use, the water level in the cistern goes below the control point. This is done to avoid pumping air into the tank, which would make the water level in this tank sink below the sight gage, *M*.

If, on account of some leak in the top of the tank, the surface should go too high, there is provided an airline, *N*, connecting the top of the tank with a compressed air storage tank, *O*, holding air at 75 to 100 lb. pressure. By opening valve *P* for a little while the level in tank *E* will be forced down, until visible in gage *M*. This, of course, could be operated automatically, by using a float-controlled valve like *L*, but I did not find this necessary, as it did not happen more than once in three months that we had to replace the air cushion. Line *Q* represents an overflow into a storm sewer, thus avoiding the lifting of manhole cover and flooding of the shop. Line *S* collects all returns from bubblers and test cooling system and leads them back into cistern *A*.

The system works as follows: City water enters the factory with an average pressure of 45 lbs. per sq. in. The pressure control of the private system is set at 40 lb. for cut-in and 55 lb. for cut-out. As soon as the private system fails, check valve *H* opens and lets water into the private system but closes again as soon as pump *C* works again. This system is so well balanced that we keep 50 lb. pressure nearly all the time. The amount of salvaged water can be read directly on meter *R*.

I had all drain lines laid in ditches filled with crushed stone, and after putting the system to work, I connected some of the roof downspouts to these ditches and made use of a lot of rain water, which, of course, entered the cistern after being strained through the drain tile.

This system worked very satisfactorily and saved the company a nice sum of money every month, as the reading of meter *R* proved, especially after the returns from the test cooling lines were connected to the cistern.

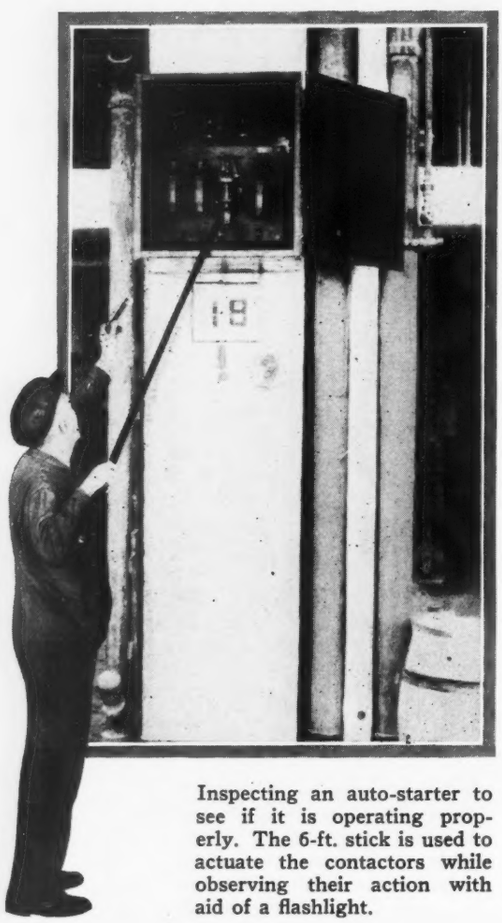
We made it a rule to stop this system every night by shutting off motor *D* and closing valve *T*, and always found the cistern filled in the morning.

Undoubtedly such a system would afford a material saving for many plants that work under similar conditions.

Take care of the STARTERS—*They will take care of the* MOTORS

By A. A. A. RODRIQUES

Maintenance Electrician
Candy Headquarters
New York, N. Y.

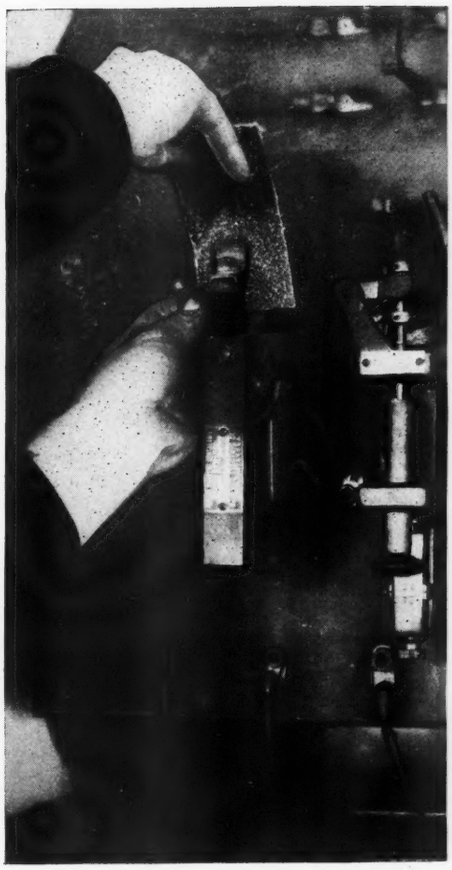


Inspecting an auto-starter to see if it is operating properly. The 6-ft. stick is used to actuate the contactors while observing their action with aid of a flashlight.

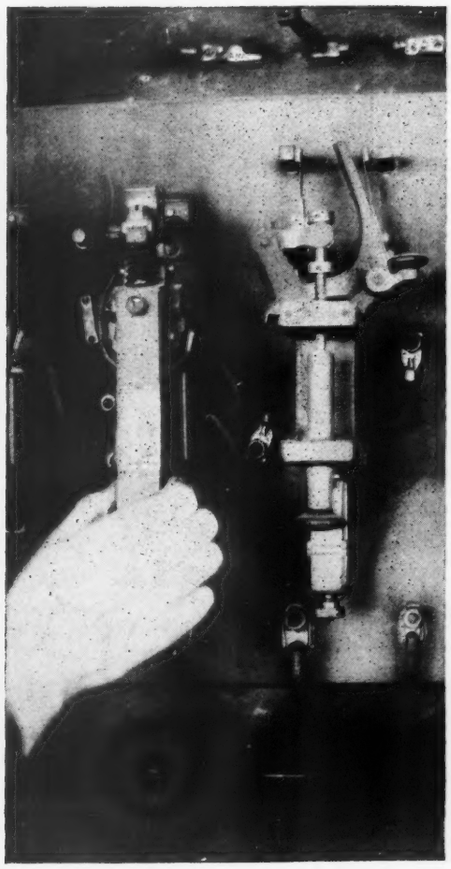
TAKE care of the starters and they will take care of the motors is a suggestion which has much in common with that old saying "Take care of the pence and the pounds will take care of themselves." All motor starters, regardless of whether they are of the automatic or manual type are subject to defects some time or another after being in service. The kind of duty; the manner in which they are handled, also the location, have much to do with the length of their usefulness. Pushing the starting button of an automatic starter and seeing that a motor starts and remains running does not always mean that all is well within the starter.

My experience with over 200 automatic starters of different classes in capacities up to 40 h.p., and over 100 hand starters in corresponding capacities, has given me a wide scope anent their efficient characteristics, points of weakness, how minor repairs can be and have been effected.

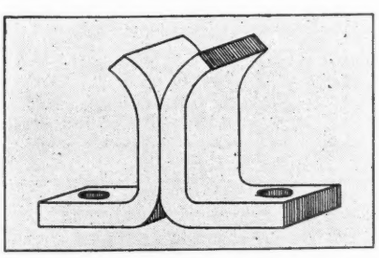
More trouble is encountered with automatic starters than with the manual types, however, this condition cannot be justly attributed to the fact that the former outnumbers the latter by a little more than 2 to 1. In the case of the auto-starter which is usually in a closed cabinet, one presses the starting button and depends upon the contactors to function in a predetermined and proper sequence. When they fail to close, owing to creeping of the air-gap adjuster if the starter is one of the magnetic lock-out types, or the plugging of vent holes if it is a vacuum-plunger type, the starting resistance which is designed to carry the heavy starting current for a few seconds becomes overheated and burns out. On starters where the holding coils of the contactors remain in series with the starting resistance which is cut out after the contactors have closed, the weakest element fails. Replacement of a holding coil is an easy job of a few minutes, but in respect to a damaged resistance it is a matter of completely dismounting an unwieldly apparatus, weighing anywhere between 75 and 125 lb., and taking off the back in order to gain access to the damaged part.



Contacts are sandpapered vertically and if coarse paper must be used the job is finished with a fine paper.



Air-gap adjustments of auto-starter contacts are neither tedious nor difficult if you use your head and hands.



Elongating the holes in these contacts extends the length of their service.

A slight change in the wiring of several auto-starters has paid for itself many times over. The procedure resulted in the compulsion of anyone starting a motor from one of such altered starters to keep the starting button depressed until the motor was across the line. With the closing of the final contactor all resistance was cut out. A lamp can also be used in conjunction with this starting arrangement by having it remain lighted until the motor is across the line or *vice versa.*

Both start and stop buttons of these starters are of a composition which expands and causes them to stick when subjected to moisture such as results from the careless handling of hot water while washing the floor or machinery. In this condition they make a permanently closed or open circuit until the trouble is removed. When practicable, a cure is effected by changing the location of the control station.

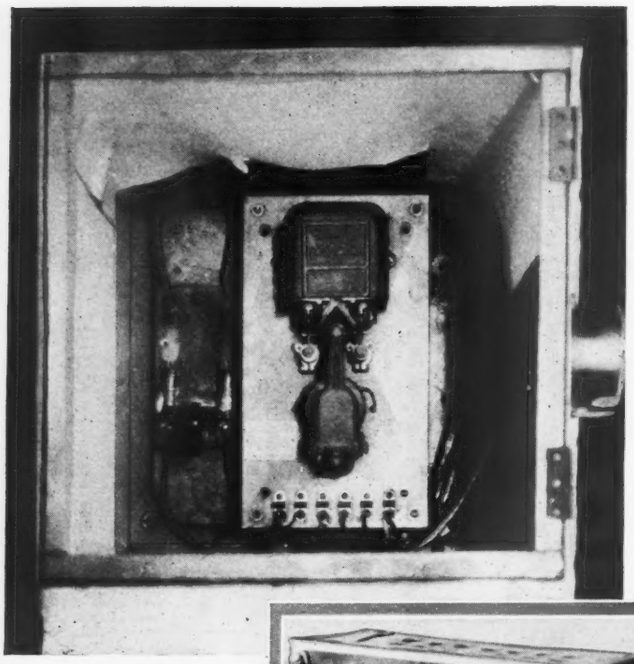
Continued exposure to moisture does more than merely affect the free movement of the buttons. It causes the moisture to soak into the slate base. A case in point was where one such station became grounded through the screws and their lead anchors that held it to the brick facing of a column. The moisture penetrated the slate and the brick filling, completing a circuit to the column.

Changing from Hand to Automatic Control

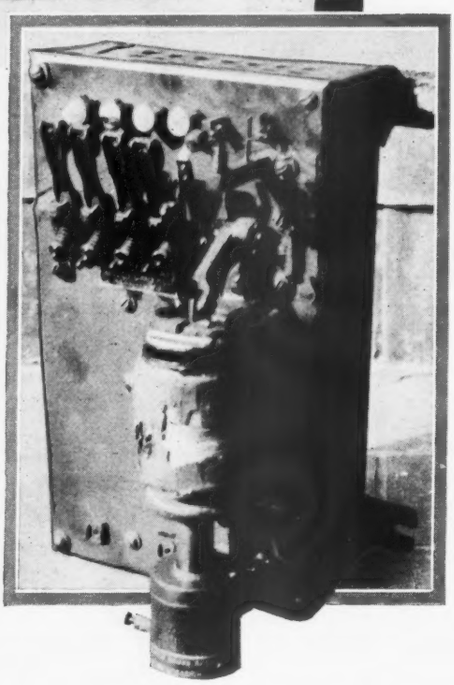
Whenever hand starters are replaced by auto-starters, whose cabinets are of approximate size, the control station is placed outside the cabinet on the right-hand side. In other cases where the auto-starters must be placed above but within immediate reach, the control station is placed directly under it and about 5 ft. from the floor, or at some other convenient location. An ideal place for locating a control station is directly on the machine.

Maintenance of Control Contacts

Contacts of auto-starters, especially those starters employing the magnetic lock-out principle, are subject to little wear excepting, of course, where machines require frequent starts and stops. An occasional rub with fine sandpaper is the most they will require under normal conditions. The faces of these contacts must be reasonably smooth because



An instance where an auto-starter was installed in a hand-starter cabinet.



What happened to the coil when the vent of this vacuum plunger-type auto-starter became clogged.

the rougher the contacting surfaces the greater is the tendency of arcing and fusing together.

In a pinch where a contact becomes so worn that it will not reach its mate, elongating the hole by which it is fastened to the contactor so that it can be pushed out the necessary distance, will prolong its period of service. Before securing it on the contactor, it and its mate must be held squarely together so that the contacting surfaces will be full and not lopsided.

Another type of auto-starter uses a carbon-disk, compression resistance. The contacts of the light-duty type are copper to copper as there isn't enough arcing between them to cause fusing, but the heavy-duty type with the attendant powerful arc is equipped with carbon to carbon contacts which hardly require any attention excepting replacements.

Whenever it becomes necessary to adjust the metal-to-metal contacts of the resistance tube care is always taken so as to obtain the maximum amount of positive contact with a minimum possibility of the slate breaking when the tube is pushed up.

Experience has shown that when this type of auto-starter begins to blow fuses without motor load, external shorts or grounds, it is a case of an internally worn resistance tube. The insulating medium with which it is coated is usually ruptured at two or more points, thereby cutting out the resistance of the carbon disks through the metals of the tube. Whenever such trouble occurs the defective tube is stripped of its usable parts and discarded.

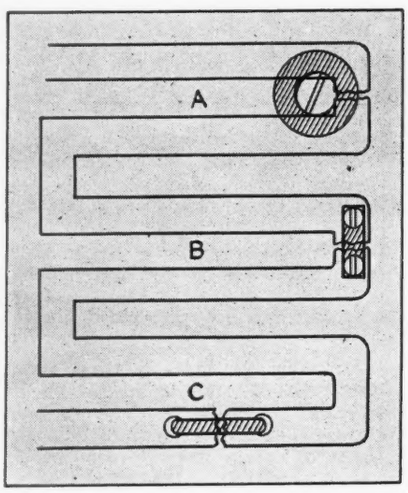
On several occasions when some motors became overloaded and blew fuses rated above the current-carrying capacity for which the plunger-type relays of their starters were set, investigation disclosed that the plungers of these relays could not be made to move without a pull of from 20 to 30 lb. being exerted upon them. The trouble was caused by the introduction of foreign matter in the oil. To remedy this condition plungers and dashpots were given a cleaning bath and refilled with new oil.

Solenoid-type relays, owing to their simplicity of construction, are not usually subject to complicated troubles, but owing to their readiness to function at the slightest increase of current above that for which they are set, very often defeat their purpose. In all but normal cases they are set far above the starting current which lasts for the 5- or 20-sec. period necessary for the motor to come up to speed. The coils of these relays sometimes burn out when abnormal overload conditions develop and continue unnoticed.

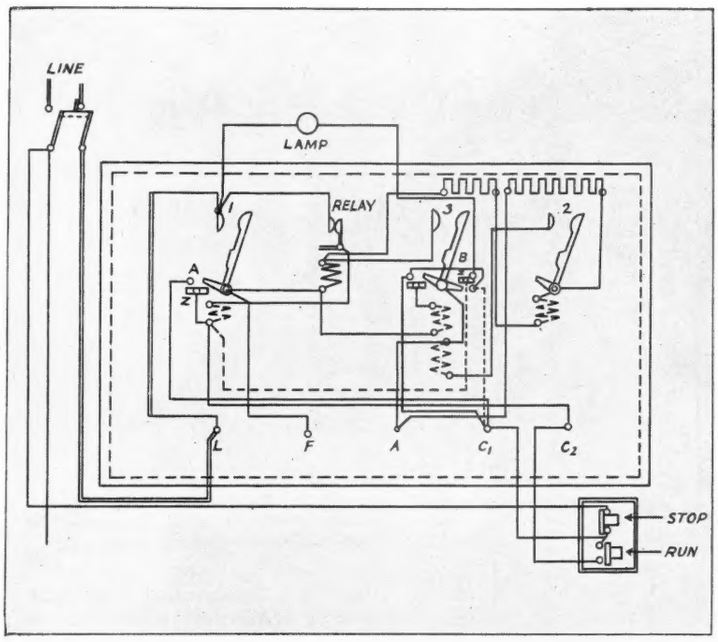
Inverse time-limit relays are, by virtue of their ability to hold a temporary overload until the motor gets up to speed, the ideal ones to use on starters when such overload conditions can be anticipated in advance of motor installations.

Auto-Starter Inspection

A casual inspection yielded profitable results when armed with a flashlight, and a 6-ft. pole having a hook



Three methods of repairing broken grids. (A) When the grid is too small to be bored use a bolt and two washers. (B) Two strips of iron are bolted or one piece is screwed to the grid. (C) Soft iron wire is bent through the drilled holes and lightly hammered down over washers.



A slight change in the wiring of this auto-starter makes it compulsory that the starting button of the control station be kept pressed in until all the resistance is cut out and the motor thrown across the line. The small contactor Z is moved from original position A and placed at B so that contactor No. 1 will not remain in until No. 3 closes and throws the motor across the line. Dotted lines indicate change of connections leading to Z. The signal lamp when used will light the moment the starting button is pressed and will remain lighted until all of the armature resistance is cut out by the closing of No. 3 contactor.

on one end. I tramped from the top floor to the basement opening auto-starter cabinets to see if all contactors were functioning properly. A record was made of cabinet numbers and locations of starters needing adjustments when they were shut down. All lazy contactors were pushed in with the pole.

Idle motors that operated from the starters under inspection were started, and if their starters failed to function as they should, they were given immediate attention.

Defective Starter Slate

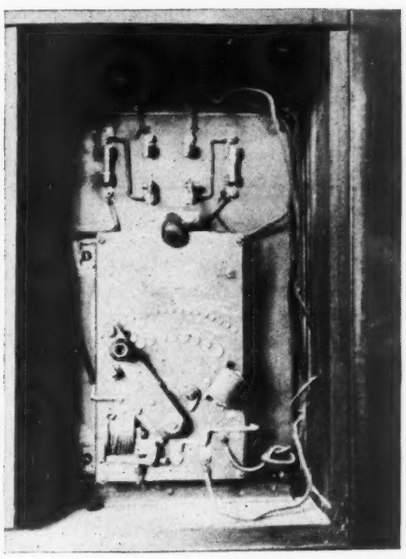
Defective slate that permits the leakage of current, whether the starter shows signs of the effects or not, is far from being conducive to efficiency. It adds to many minor ills and hastens breakdowns when the starters appear to be functioning properly.

On one occasion while changing brushes on a 20-hp. motor my elbow made contact with the motor frame. I felt a sting but little notice was made of it at the time, but the repetition of this sting was so annoying that I decided to investigate. After reassuring myself that the switch in the starter cabinet was open, I returned to the motor and crossed a screwdriver from the brush holder to the motor frame. The flash that resulted would have done credit to a battery of 6 dry cells. A subsequent examination brought the cause to light. The slate of the starter serving this motor was found to be lined with metallic veins.

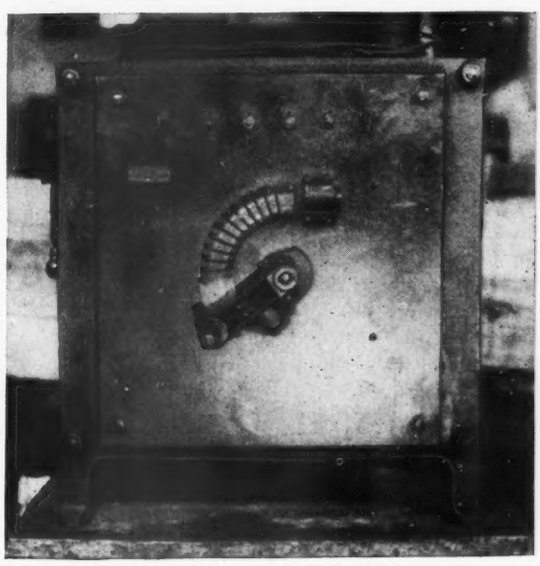
It was designed to be screwed to its cabinet which made the current leakage more effective. Consequently whenever any work requiring handling of the brush holders of this motor was to be done, the freak live circuit was grounded with a piece of light fuse wire. Failure to remove it after the work was finished caused little harm for as soon as the switch was closed and the motor started the fuse wire parted.

Common Faults and Repairs

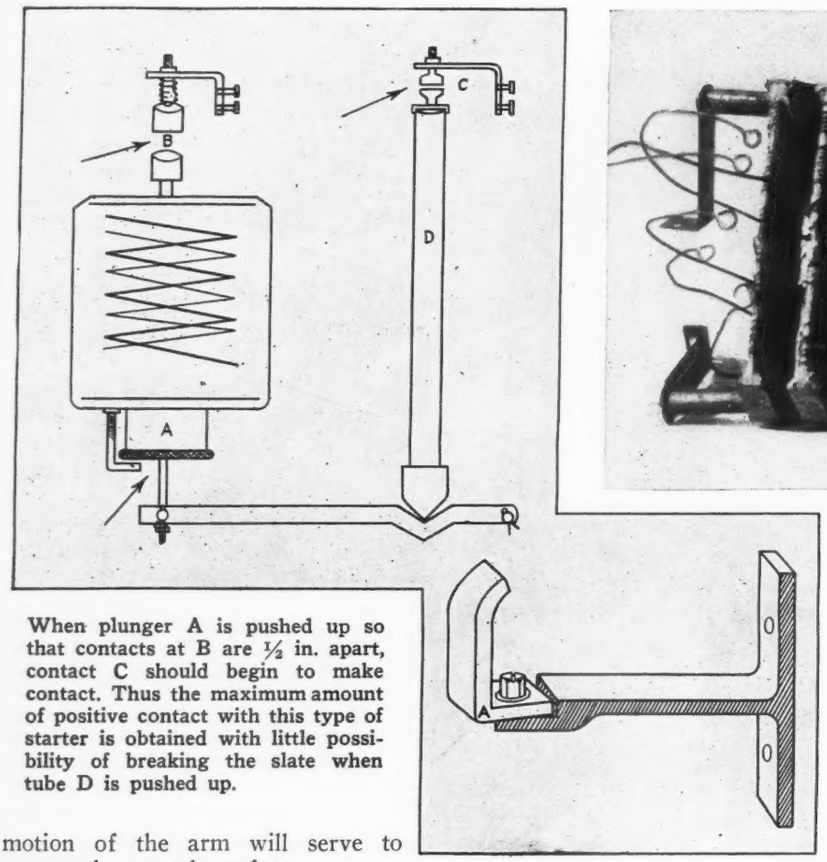
Where exposed to the dust of certain operations, the contacts and moving parts of hand-starters become coated with sugar, which not only prevents the starting arm from falling back to the off position when the switch is opened, but also renders the contact less complete when the arm is passed over the contact points. The application of fine sandpaper over the contact points in a line with the direction corresponding to the



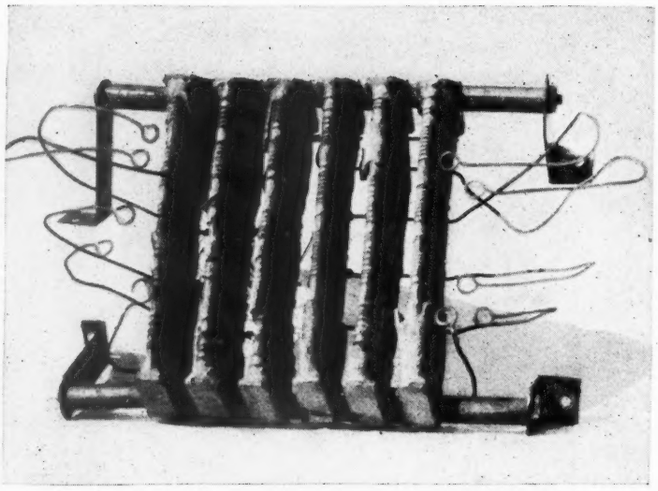
Here, powdered sugar settles on starting devices thereby impairing their efficiency.



In an emergency when repairs cannot be made immediately this portable hand starter is taken to the location and placed in service.



When plunger A is pushed up so that contacts at B are ½ in. apart, contact C should begin to make contact. Thus the maximum amount of positive contact with this type of starter is obtained with little possibility of breaking the slate when tube D is pushed up.



When resistance units approach this state they are beyond repair.

There is a likelihood of a lop-sided fit after elongating the hole in the contact so as to increase its projection. Full contact may be obtained after tightening slightly by tapping at A while matching it with its mate.

motion of the arm will serve to restore the smooth surface.

In a few cases, the arms of some sluggish field-regulating starters equipped with overload relays which functioned by short-circuiting the holding coil would not drop back when the relays were held in the operating position. Only when the motor switch was opened and the motor came to rest would they do so. The arms, complete with the pivots, were taken off and given a thorough cleaning, thus a remedy was effected.

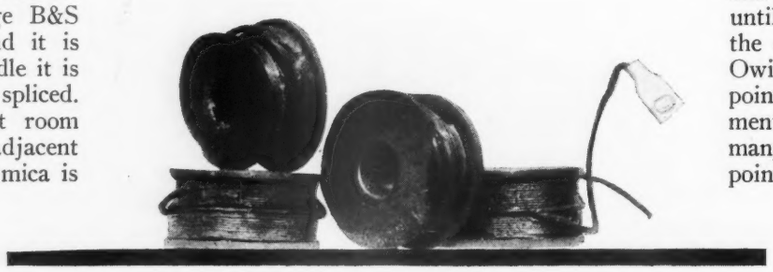
Repairing Resistance Elements

Replacements are sometimes cheaper than repairs, but at other times an emergency repair is worth the cost of several replacements. Generally, hand-starter resistances are of two kinds, wire and grid, and although their repair has a common purpose—the re-establishment of a circuit—these repairs must be carried out differently.

When a single turn of resistance wire, 28-gage B&S or larger, breaks and it is not too brittle to handle it is carefully scraped and spliced. If there is sufficient room between it and the adjacent turns a thin strip of mica is placed under the splice and over the adjacent turns. If the damaged wire proves to be too brittle to handle with pliers strips of thin brass or copper are wired down to it with mica above and below the repaired part. When the resistance wire is very fine and the break can be located very thin leaf brass is used, care being taken not to cover more area than is needed.

Whenever a wire resistance burns out in two or more places it is not always advisable to repair it because the amount of current increase in the repaired part would make short work of the rest of the coil.

In cases of emergency grid resistances are temporarily repaired by attaching suitable jumpers across the broken parts without cutting out much or any of the resistance. When opportunity permits the broken grids are taken out, and a hole having a diameter of one-third the width of the parts to be joined is drilled about ½ in. from the broken ends. Two strips of metal and two bolts complete the job. If space does not permit the use of bolts the holes can be tapped and the splicers screwed into place. Another method is to use soft iron wire with thin washers riveted onto the grids.



Contact Points

In normal operation contact points of hand starters are subject to little wear, but when these starters have to be used to give a machine or other apparatus a half turn two or three times a minute, the first and second contact points deteriorate very rapidly from the resultant heavy arcing.

In repairing starters in this condition the point burnt most is replaced by the dead point—the point on which the contact shoe of the arm rests when in the off position. Then the burnt surfaces are filed smooth and built up with washers until they are level with the others when replaced. Owing to the fact that all points are alike, replacements can be made as many times as there are points on the starter, less one when there happens to be no dead point.

PLANT • ENGINEERS' • FORUM

* * *

Here is the fourteenth of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to previous questions also will be published. Write down your opinions and send them to the editor. Answers published will be paid for at an attractive rate.

* * *

Who Shall Specify Equipment?

Frank Fulleger has something on his mind, and has driven to George Shipman's house after supper to have a round of conversation by way of setting himself straight. The mosquitoes buzz frantically, but Frank and George give them no attention as they take their ease in comfortable chairs on the screened porch.

* * *

"I never did understand a purchasing agent, anyway, George. All they can think of is price. You remember those roller bearings I've been yelping for? Well, I'm going to get them at last, and the kind I want, too; but I had to put up some fight to get them."

"How come? Didn't you write the specifications? And didn't you put it down in black and white that you wanted Robinson bearings?"

"Yes, I did, and then when I went over the orders with the works manager before he signed them I found out that Smith bearings were specified."

"And what then, Frank?"

"Boy, I got warm—asked firmly, and I'm afraid none too politely, who was changing my specifications. Found out it was the purchasing agent, who figured he would save a lot of money. Then I said a few things about people who will spend only $6.98 when $7 will give almost twice the value; gave a sermon to the effect that bearings are not just something to let a shaft turn around in; and then got down to details as to why I want Robinsons. George, I was warm."

"And how did the W.M. take it? Any comeback?"

"Oh, yes—told me very calmly that I was right, but that the P.A. was right, too, because it was his job to watch prices and to get things as cheaply as possible. Said the P.A. was acting under his instructions and that he was having me go over the orders with him just so he could find out which bearing was going to be cheaper in the long run. Scratched out Smith and put in Robinson right then and there."

"Don't see that you have anything to worry about, Frank. Got what you wanted, didn't you?"

"Yes, but it's the principle of the thing. Am I going to have to defend my specifications every time the P.A. thinks he sees a chance to save a nickel?"

"I don't know just what your big boss has up his sleeve, Frank, but whatever it is, I'll bet it's O.K. I know him well enough for that. And I know he wants to feel certain that he can rely upon you for specifications—hasn't the time himself to go into all the details. And don't forget that your purchasing agent is nobody's fool either. If you'll be patient for a few minutes I'll give you a little dissertation on P.A.'s plant engineers, works managers, specifications, their relative importances, interrelations—. Guess I won't, either. There's Mrs. Shipman with her bridge friends, and I see where yours truly is in for an evening of social duty. Rather talk shop, but you know how it is, Frank. Take a hand, will you?"

"Not for me, George, not for me. I'll get on back home and we'll finish some other time."

* * *

Our acquaintance with George and Frank leads us to believe that Mrs. George prevented a long, long argument. Perhaps it's just as well—our readers can take up the discussion where the two men left off and doing so will give them an opportunity for some original thinking.

What should be the relation between the maintenance department (or plant engineering department) and the purchasing department in regard to specifications for plant equipment?

(Answers to previous questions start on the following page)

READERS' ANSWERS

to previous questions

What Maintenance Policy During Depression?

(Question presented in the September issue)

CERTAINLY prepare for future production during a period of depression—that is, if the company can finance it. During the present depression, it has been impossible for some plants to prepare for future business because they cannot afford to spend the money with very little coming in and no prospect of an increase in business for some time to come.

I think every one will agree that the time to overhaul your equipment is when a plant is shut down. There is some overhauling that cannot be done except when the entire plant is shut down, such as overhauling or replacing engines, generators, etc. Individual machines can be overhauled while the plant is running, but, even then the superintendent does not want to shut down even one machine when he is pushed to get the work out on schedule.

Prepare for future production during depression as far as finances will permit.

J. WALTER WRIGHT, *assistant to the president*
Wilmot Fleming Iron & Steel Company
Philadelphia, Pa.

PREPARING for production during periods of depression is logical, but in a large plant where a maintenance crew of fair size is maintained, it should be possible to plan the work so that this preparation can be carried on without adding to the crew or sacrificing vacations. Past experience will determine the size of the maintenance force that should be carried regularly, and, if the work is given proper thought it will be found usually that this force can carry on successfully through busy times and slack.

An inspection of any plant will indicate that there is a large amount of maintenance work, which, while not urgent, should be done to keep the plant in proper condition. Inspection and the performance of minor repairs, before breakdowns actually occur, will pay big dividends. This kind of work can be done when there is nothing of greater importance to interfere with it. During times when it is necessary to install new equipment, or do major overhauling jobs in any department, the routine maintenance can be sidetracked until the more important work is completed without serious inconvenience to anyone.

The important point not covered in your discussion is the fact that fluctuations in the maintenance force are expensive and should be held to a minimum. In any large plant there is a lot of special equipment to be maintained and it usually takes several months before a mechanic is trained properly to take care of such apparatus. It is unfair to expect any mechanical department to overcome the mistakes in judgment on the part of the management, but with any ordinary degree of cooperation the maintenance work can be arranged so that the regular force will be able to take care of any seasonable preparations without upsetting the organization. A well-trained maintenance force is a great asset to any plant, but such training takes time and cannot be carried out effectively if this force has to be varied with the season.

C. W. SCHWABE, *Mechanical Department*
Mallinckrodt Chemical Works
St. Louis, Mo.

MOST emphatically the best course to follow is to prepare for the production that is ahead. At present there are definite signs that we have passed through the worst of the depression.

We buy materials, if we think the price will rise, to save the difference in cost. We design and tool up for a new machine because we believe there is a demand for it. Such steps involve a certain amount of speculation based on our business sense. Our maintenance problems can be approached in the same way. During a period of depression our maintenance problems can best be solved. Things can be bought at lower prices. Machines, men, and materials are cheaper.

Replacements made in slack periods will tend to stabilize production and will have a favorable effect on the welfare of any community. Also, in the period of increased production which inevitably follows a period of depression, the company having the equipment will have the advantage of being able to carry out production schedules and will not have lost the benefit of quick deliveries on new equipment. It will have been able to do construction work when the plant was not running at capacity.

Having machines ready and in good shape is insuring profit in the days to come when the rush to meet production schedules returns.

Wall Street fluctuations in reality affect only those whose poor judgment caused them losses. Their judgment can be expected to be as inconsistent as their

J. WALTER WRIGHT

Assistant to the president, Wilmot Fleming Iron & Steel Company, Philadelphia, Pa., starts the department off this month with his answer to the last question "What Maintenance Policy During Depression?"

sporting blood. When they win, they act very modestly, but the company which issued the stock they played does not gain anything; when they lose, though the company does not lose anything, they become very dejected, and make all who come in contact with them listen to wisdom. The fact that cash reserves are high, order books are filled, far-seeing directors are in favor of the move, and "machinery is obsolete" should overrule the personal disturbances of a few and should lead to purchase of new machines, material, and other necessities for coming production.

If all companies would wait and see what the trend of business is going to be, there would be no business at all. Some one must start and keep the ball rolling. After all, it is not the gambler's losses, or the failing of a company or two, that causes hard times. When the buying public stocks buying, the merchant cannot order; without orders the manufacturer cannot employ. Let the world know that you have money and that it is going to be spent. You are going to order equipment and materials, your suppliers in turn are going to have an order, and the result will be felt all the way down the line.

HARRY KAUFMAN, *Engineering Department*
Naval Aircraft Factory
Philadelphia, Pa.

Do Centralized or Decentralized Stores Better Serve Maintenance?

(Question presented in the August issue)

I BELIEVE that both centralized and decentralized stores have their place in most plants. But I do not imply by this that every nook and corner in the plant should be a private collection of stores.

Take my own department as an example: I have always believed that I could save money for my company, through expedited repairs and shorter equipment delays, by having a small store in connection with the electrical repair shop. Only a few items that are usually needed in a hurry are kept in this storeroom, such as contacts for compensators, motor bearings, and under-voltage release coils. Materials such as snap switches, lamps, tape, small sizes of wire, and brass sockets are kept in the main storeroom.

I feel that the company is benefited by this method of stores in the following way:

1. An under-voltage release coil burns out, shutting down a motor. The electrician notified of the trouble can get a new coil and have it replaced, in many cases, by the time he can get a written requisition on the storeroom. Assuming that the workman does readily obtain the requisition, there is usually a delay at the stores delivery window. Then, too, it is a rare storekeeper who will always know the desired article.

2. Night repairs are more easily taken care of. This is a very important item, as help is scarce, and usually no storekeeper is on duty.

3. It is easier to keep up the stores, as they are placed in individual bins and tagged, as to the switch or other piece of equipment that they fit. These bins are watched very carefully to see that enough material

C. W. SCHWABE

Mechanical Department, Mallinckrodt Chemical Works, St. Louis, Mo. His opinions regarding maintenance operations during depression will be found on the preceding page.

is kept in them to take care of emergency repairs. When this supply is exhausted a new one is obtained from the main storeroom. If this batch depletes the main storeroom, the regular supply is ordered which will remain in the main stores until needed.

4. Sunday work is speeded up, due to having materials readily accessible.

There are several reasons why a centralized storeroom will not have spare parts in stock when needed:

1. Storeroom record system not what it should be.

2. Storekeeper not on the job, and if he is, he is subject to human forgetfulness and errors.

3. Requisitions from the stores not entered daily on the balance record cards. Then, too, one may be lost or misplaced and the shortage will not be discovered until inventory time, or until they are needed.

Department heads for their own protection should occasionally look over their own stores even though they are kept in a centralized storeroom.

Department heads can further assist the storekeeper in keeping his stock up by figuring out jobs that require a heavy run on the stores far enough in advance to order the material before it is needed.

The maintenance department is the one that needs most parts in a hurry. But if this department is located near the main storeroom there will be very little use for a stores department in the shop.

MARIN PHILLIPS, *Electrical Superintendent*
International Paper Company
Niagara Falls, N. Y.

Do Distributors Serve Industry Economically?

(Question presented in the June issue)

THE prompt delivery of supplies is one of the prerequisites for efficient maintenance. The mill supply house may be considered as filling an important economic function—being the connecting link between the customer and the factory—assuming, of course, that it is organized to supply the complete wants of the customer who is using the article or equipment for which the supply house is agent.

The distributor should be equipped to take care of the smallest wants of the customer and also be ready

with technical salesmen to advise and suggest on all and any problems in connection with its equipment. If it fails in this respect it is not an asset but a liability.

A salesman who has his customers' interests at heart, and who is backed up by his house, whether a distributor or a straight branch of the manufacturing company, can do much toward lessening the spare parts stock to be carried by the maintenance department of the customer. If the latter knows that he can call for any article needed, from the equipment or supply house, and be sure of getting it right away, he is going to be a regular customer and a booster for the manufacturer. A salesman who is on the job all the time with his customer advising him on the latest equipment, foreseeing some of his needs, becomes an asset that is not to be dispensed with easily.

In our line of business, designing and installing compressor plants, we are in close contact all the time with the sales engineers of the companies making pipe, fittings, and valves. It is of great value to be able to know that everything needed on the average job is at hand, or what will be the date of delivery. We also get the latest information on the trade in general, especially with regard to the fluctuation of prices.

The supply house, if the factory is situated at a great distance, usually has a full and well-equipped warehouse service. In the compressor and pump field there are usually factory trained men with the supply house. These men make it their business to help the operators. They are armed with information concerning the latest factory developments whereby more efficient maintenance may be effected. Where the factory has its own distributing branch there are always highly-trained, direct-from-factory service men. These sales engineers constantly are visiting users of their products, not necessarily to make immediate sales, but to help out with ideas.

If the factory is near the customer it is cheaper to buy direct. If far away, it is no doubt cheaper to buy from the supply house for the reasons previously outlined. I had the experience of buying a rather complicated regulating valve from the factory. There was quite a problem in connection with its installation and somehow we could not get results. Long letters were exchanged between ourselves and the factory and finally the valve was returned for credit. Our problem was then taken to a supply house which had a factory-trained man. He worked with the valve until it was giving dependable service. The factory article was cheaper in the first place but we lost out on service. We now feel that the valve sold by the supply house is the only reducing valve for us and the order has been repeated often. We can get any spare parts from stock. The salesman is what we may call a friend of the operations and maintenance department and naturally he has sold us more of his products.

As engineer to engineer, the maintenance engineer feels more confident in the service and the product of a man who can talk in inquiry terms, than in those of the high-pressure salesman type.

MAURICE C. COCKSHOTT
J. B. Hill Corporation
Long Beach, Calif.

F. J. WOLF

Mechanical Engineer, Homestead, Pa.; an interested follower of Frank and George and a frequent contributor to these pages.

Should Maintenance or Production Department Control Cranes, Elevators, and Trucks?

(Question Presented in the April Issue)

AT times this becomes a perplexing question, and a compromise between the two departments is the only solution.

In the sheet metal plant (a rolling mill with auxiliaries consisting of galvanizing, roofing, and warehousing departments) this compromise works out to advantage.

The following method is in use in several plants with which I am familiar and gives good results:

The chief electrician is charged with all inspection and maintenance of electric cranes and tractors. He also is charged with the procurement of the operating personnel. When these operators are hired they are given to understand that they will look to the chief of the maintenance department for the care of their time and rates, and that he will settle any grievances. At the same time they are given to understand that they must give the department in which their respective machines are located the maximum of service, the chief of this department to furnish all the operation orders.

With these two positive injunctions they are furnished with a copy of the safety rules as furnished by the corporation and are instructed not to make any lifts or move any materials which their best judgment says is not in line with safety. Whenever a question of this sort arises they must refer it to the head of the maintenance department for settlement.

This plan in operation is very successful. The only time when friction has developed has been when a single crane must service several departments. For example, a single crane in one location must furnish the following services: changing the rolls in hot mill roll train, transferring sheets from hot to cold mills, and servicing the lathes for roll turners. As a rule this friction is occasioned by the heads of departments feeling that their service should take precedence over that of the others. This in every case has been overcome by placing in these locations operators who seem capable of exercising tact.

H. E. REINHOLD, *Chief Electrician*
Dover Plant, American Sheet & Tin Plate Company
New Philadelphia, Ohio

How Develop Key Men for Maintenance Work?

(Question presented in the March issue)

THE process of developing men for responsibilities and departmental organization depends entirely upon the size of the plant. The small plants, unable to carry a large number of maintenance men, must necessarily depend upon the "jack of all trades" who can turn his hand to most anything to get by and keep the plant running. That is about all he does—gets by, and sooner or later someone must come in who is a specialist in that particular field and straighten out the situation so that efficient operation will be the result.

A large plant, however, must specialize and subdivide the work, so that the men who are familiar with certain phases of the maintenance department can be proficient in their daily job. The work should be divided into as many departments as possible, consistent with operations, and each man held for that department's operations.

We should have electricians, carpenters, millwrights, lubricating men, steamfitters, plumbers, yardmen, crane men, motor repair department, power plant operators, and other subdivisions where necessary.

These departments should be under the charge of the plant engineer who has foremen heading up each separate department. When these departments are large enough to maintain subdivisions, each departmental foreman can allocate certain phases of his work to special men. In this way they may be proficient in their respective jobs and know the plant equipment, so that no lost time will ensue in arriving at a decision which might be necessary in making repairs.

Each foreman who plans for the future can break in new men and keep a sufficient number coming along to fill in for responsible positions should vacancies occur.

It takes a long time to break in a new man for a large industrial plant regardless of how proficient he may be in his speciality. He must be familiar with all of the intricacies of the plant design and construction. Each building should be carefully studied if there are many buildings in the group, to know where all of the various equipments are located, and their relation to each other. He must become acquainted with the personnel of the different factories and their method of operation, in order to thoroughly understand his work.

Instances are known where it would take at least three months for a man to be able to go on his own in a large institution because of the necessity of learning the trade and manufacturing customs of that particular industry.

The plant engineer should have a well defined policy of training and advancing men in his department in order to obtain the best results and a continuity of service for all production machinery.

K. D. HAMILTON, *Mechanical Department*
Geo. E. Keith Company
Campello, Brockton, Mass.

THERE are key men to be found in every industrial plant; some employed because of their experience, others trained on the job, It does not always work to advantage, however, to have one key man for every key position, since it places the plant and equipment in a dependent position. For instance, if one man was held responsible for the storage battery trucks and these trucks were used on three shifts, too much responsibility would be placed on that man by others during his absence. On the other hand, temporary repairs could be made to mechanical equipment during the absence of the key man (millwright or master mechanic) and then properly repaired when he comes on shift.

Here is the manner in which the work is allocated in one large industrial plant: In the electrical department there is one key man for each eight-hour shift. Two of these men are alone on their shifts, while the third on the day shift, may call on the day maintenance crew consisting of three men. The men on the other shifts can call on anyone who happens to be temporarily idle, because of the shutdown of any of the departments.

The duties of these three key men consist of oiling and inspecting motors, replacing fuses, putting truck batteries on charge, replenishing batteries with distilled water, making repairs to signal and lighting systems, changing motors when necessary, and other routine work in connection with electrical equipment. Most of these men were trained at the plant since the equipment under their control at the present time was, in a great many cases, not even heard of when they were first employed. It might be said that they simply grew up on the job. They are responsible to a day foreman in charge of construction and maintenance who in turn is directly responsible to the electrical superintendent.

Unless responsibility is divided in this manner, an industrial plant is apt to suffer heavily if something of a serious nature happens to the equipment while the chief or his assistant is out of the plant or is incapacitated through illness or accident.

It can be seen from the foregoing that our three key men are kept so busy that they have little or no time to prevent trouble, unless indications appear when they are on the spot. Right here is where the next key man, the day foreman, steps in. His duties take him to all parts of the plant on what is, or should be, a constant inspection trip. He is able, therefore, to spot unusual wear, hot bearings, excessive noise, and other signs of impending trouble and to pass this information along to the men under him. The electrical superintendent, constantly in touch with other phases of operation such as load and operating conditions, general condition of equipment, etc., is also able to foresee future trouble from this angle.

The same procedure is followed in the mechanical department where such key men as the head machinist, welder, tinsmith, pipe boss, paint boss, and others, report to the master mechanic. The millwrights, also responsible to the master mechanic, have a key man for each group of buildings.

Key men necessarily must acquire most of their knowledge from experience, but it is important that they be instructed in their work and helped by means of literature pertaining to their equipment for reference and study. Manufacturers usually send circulars and instructions for installing and maintaining their equipment and these should be read carefully and filed for future reference.

H. E. STAFFORD, *Electrical Engineer*
Port Arthur, Ont.

The watchman has "set-up" his register or key by visiting all preliminary stations in sequence and is now ready to actuate the transmitting station.

It is better economics to install equipment and services designed to protect property and to prevent fire and burglary losses, than it is to collect the insurance after the disaster has occurred. Insurance does not compensate for lost profits.

POLICING ELECTRICALLY

Guarding Automatically Against Fire and Theft

By RAYMOND K. HYDE
Commercial Engineer
American District Telegraph Company
New York, N. Y.

SINCE the World War more people have been burned to death in the United States than were represented by the entire number of American casualties in the war. Careful analysis of the bulletins of the National Fire Protection Association reveals the fact that carelessness and improper protection are the leading causes for this tremendous economic loss.

Burglary goes hand in hand with fire as a source of loss to business. Even the casual reader of the daily press is aware of the serious losses from burglaries. It has been proved time and again that the results of fire and theft are reflected in the statement of earnings long after the fire has been extinguished or the thief has made his getaway.

Adequate protection can prevent much of this enormous loss. Modern science and invention have provided a system of protection against burglary and fire which is on duty constantly to guard against these arch-enemies of production and profits.

This system, which is called "Central Station" service, includes electrical and mechanical equipment which transmits warning signals whenever normal conditions about a plant are disturbed.

These signals are noted in an outside central station where trained and experienced operators and guards are ready to respond immediately in case of emergency.

Central station service provides a number of types of protection, the most important of which are burglar alarm, watchman supervision, manual and automatic fire alarm, and automatic sprinkler supervision. The type of service rendered, of course, depends upon the individual requirements of the establishment (commercial or industrial) to be protected.

Night Watchmen Supervision

An adaptation of the service is the supervision of night watchmen. A survey reveals that the average industrial plant is unoccupied more than 68 per cent of the time—that is, industrial and commercial properties are left unprotected unless watchman service is used.

Upon the shoulders of these more or less aged watchmen rests the responsibility of caring for valuations running into billions of dollars. They must guard against fire and protect the plant against burglars. Many of them are old and are sub-

ject to spells of sickness or complete collapse. There is always the possibility that thieves will enter and overpower them.

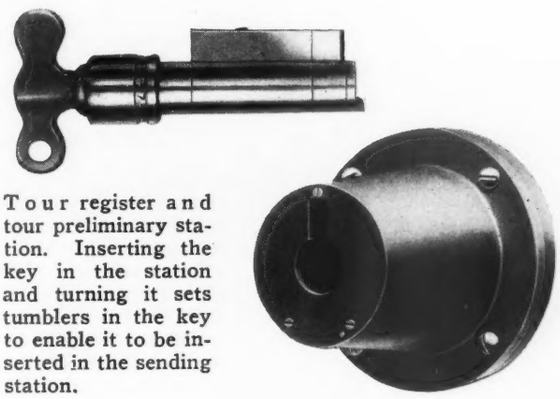
By the central station form of supervision watchmen are required to make rounds of signal boxes at certain intervals, and to transmit signals to the central station. If, for any reason, no signal is received when it should be, central station roundsmen are immediately dispatched to determine the cause for the delinquency.

"Forgot to send signal" is a prevailing excuse for failure to signal. "Watchman sick or disabled" is another frequent excuse, and in this case the central station service requires that the roundsman summon medical assistance, notify the owners or executives of the plant, and then take the place of the watchman until a substitute appears on the scene.

The supervision referred to is a system providing for continuous supervision of the watchman through an outside central station operated by an organization whose sole business is property protection, contact being maintained with the watchman by trained and impartial operators from the time he assumes his duties until he is relieved, and provides for the correction of any irregularities, even to the extent of providing substitute watchman, if necessary.

Compulsory Tour Systems

A refinement of the central station watchman supervision is the "Compulsory Tour" system. The equipment necessary consists of a self-setting register or key, one or more signal-transmitting stations, and a series of so-called preliminary stations. The preliminary stations are not wired or connected with the central station. However, each must be visited by the watchman on a regular schedule, as his key must be inserted in them in a predetermined order. He must visit preliminary station 1, then 2, and 3, each time stepping up the register or key so that it will enter the succeeding station. He cannot skip station 2, because if he does his key cannot be inserted in station 3. When he completes his round of preliminary stations, he can send his signal from the transmitting box, the only one wired to the central station.



Tour register and tour preliminary station. Inserting the key in the station and turning it sets tumblers in the key to enable it to be inserted in the sending station.

Among the advantages of the compulsory tour system is the elimination of much wiring from preliminary stations. Other important advantages are the necessity for operating the stations in a predetermined order, and the possibility of placing the preliminary stations in obscure and remote locations, assuring a thorough patrol of the premises. The system also premits greater convenience in relocating the stations should the necessity arise.

Typical scene in a central station of one of the large operating companies. The devices on the right hand side of the switchboard are burglar alarm drops. The relays on the left hand side control the tape registers on which night watch, fire alarm and sprinkler supervisory signals are recorded.

For Distant Properties

Where desired, and especially where the plant is too remote to be reached by central station roundsmen quickly, a "call-back" service is rendered. The central station sounds a system of bells over the entire plant in the event of failure of the watchman to send his signals at the specified time. These bells continue to ring until the watchman answers or until the roundsman arrives.

Several actual incidents illustrate how central station supervision protects the watchman:

The watchman of a building found himself trapped in a stalled elevator just as he was starting his rounds of the compulsory tour stations. A short time afterward the roundsman from the central station found him and was able to bring immediate assistance to release him and repair the elevator.

Recently, burglars overpowered a watchman employed by a silk mill, bound and gagged him, and stole some tens of thousands of dollars of valuable material. The watchman was found several hours later by a milkman—long after the law-breakers had made a safe and unhurried departure. This watchman was *not* supervised.

In direct contrast with the above, four men held up a watchman in an automobile warehouse and were attempting to make him open the safe. When no signal was received from the watchman, two roundsmen were dispatched from the central station and as a result the crooks were caught red-handed.

The American District Telegraph Company reports that in a year the total number of watchman's failures to transmit signals was 353,533. Without the strict central station supervision the number of failures would, of course, have been many times larger. In some cases the watchmen needed assistance; in others they were lax in performing their duties. The patrol efficiency established by central station supervision was 99.43 per cent.

Supervision of Sprinkler Systems

Another important form of fire protection which has been assumed by the various central station protection companies is that of supervising automatic sprinkler systems.

Supervision by a central station provides that immediate action be taken when the water flows. Sprinkler heads open automatically and discharge water at the rate of 30 gal. per min. After the fire is out immediate attention must be given to the turning off of the water so that the damage will not be excessive. When water-flow signals are received in the central station an alarm is usually transmitted at once to the fire department or other protective organization delegated to respond.

Other functions of sprinkler supervision are to make sure that the shut-off valves are open to allow flow of water, that the pressure is sufficient, that there is water in the gravity or pressure tanks, that the temperature of the water is above the freezing point, and that there are no leaks.

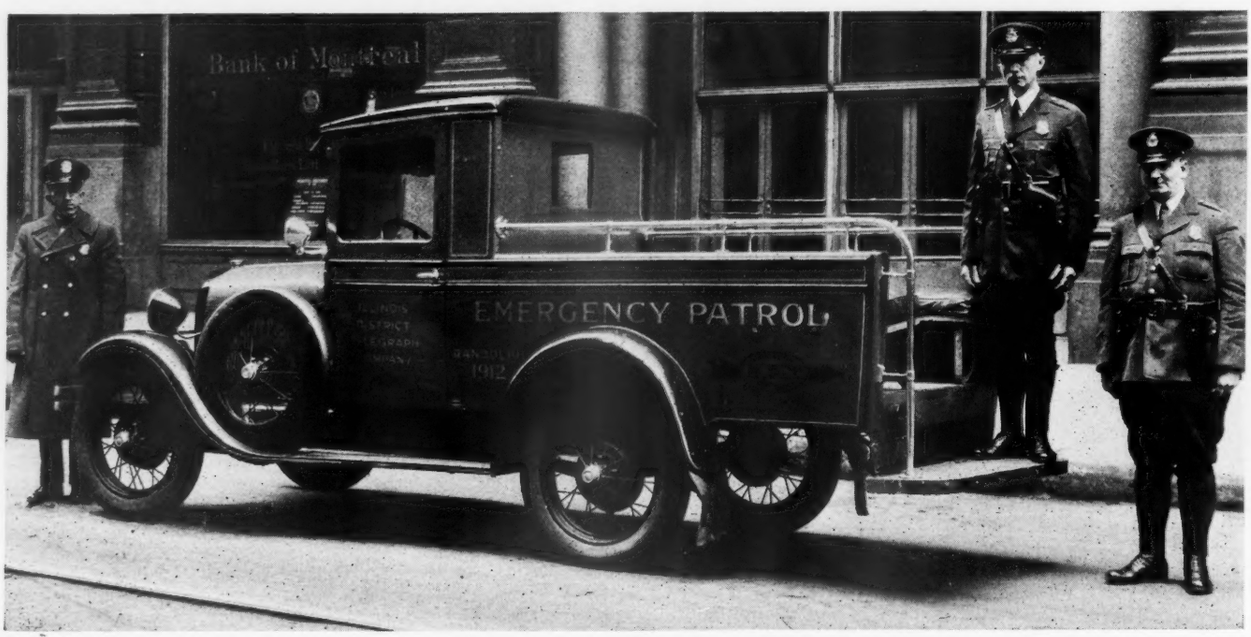
An idea of the efficiency of sprinkler supervisory service is gathered from the fact that during 1929 the percentage of fire loss against the values protected was but 0.04 of one per cent, or an efficiency of 99.96 per cent.

Burglar Alarm

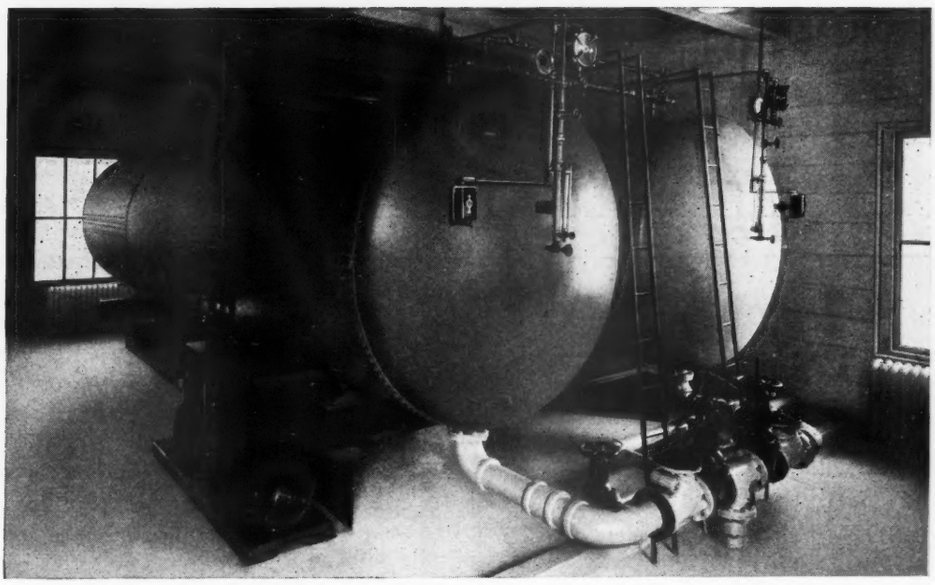
To provide burglar alarms each establishment is connected to the central station by an individual wire. The doors, windows and even the walls, ceilings and floors are protected by wires which carry an electric current. It is impossible to impair the efficiency of the system by cutting the wires, because this is the principle on which the system operates and doing so will cause an immediate alarm at the central station.

Even those who break the law are aware of the protection afforded by this modern system. Recently, according to the records of the American District Telegraph Company, a burglar was arrested by a guard who answered an alarm from a prominent store. The burglar stated to the judge that he thought he was entering the premises next door, which were not protected, and that he had had no intention of entering the store which he knew to be protected.

It is extremely difficult for the criminal to rob a protected store, as is evidenced by another case. Three men entered a store by cutting a



Emergency patrol attached to a central station for responding to burglar alarms and emergency situations.

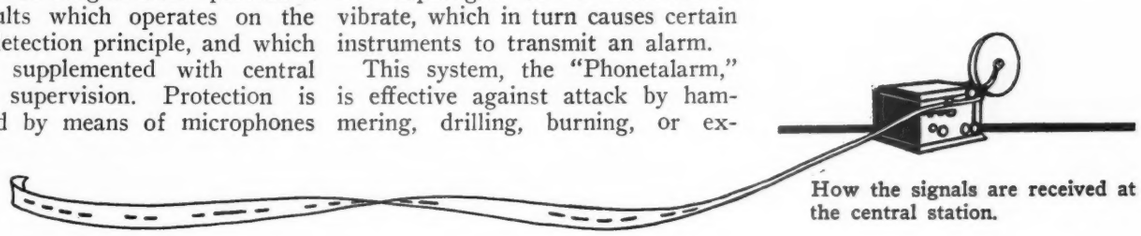


The air pressure, water level, and shut-off valves of these pressure tanks are under central station supervision. The supervisory devices are marked with an arrow. This equipment is part of the supervised sprinkler system in the building of the National Board of Fire Underwriters, New York.

hole through the unprotected roof. They collected what they wanted and prepared to leave. Their mistake came when they opened a door which was protected; the signal was flashed to the central station and within three minutes the guards and police arrived to arrest them.

Many leading banks are now using a system of burglar alarm protection for vaults which operates on the sound detection principle, and which is also supplemented with central station supervision. Protection is provided by means of microphones or detectors installed on the ceiling of the bank vault. Any attempt to force an entrance into the vault necessarily causes noise; this causes the diaphragms of the detectors to vibrate, which in turn causes certain instruments to transmit an alarm.

This system, the "Phonetalarm," is effective against attack by hammering, drilling, burning, or explosion. A series of sharp blows on the vault will cause an alarm to be given and will bring a corps of trained and armed men to investigate.



How the signals are received at the central station.

Maintenance Prominent in Program of Second National Industrial Congress

JUST completed are arrangements for holding the Second National Industrial Congress featuring Management, Maintenance, and Materials Handling in the Public Auditorium, Cleveland, Ohio, April 13 to 18, 1931, inc. In conjunction will be held the Second National Industrial Equipment Exposition.

Following the lines of the first exposition, held in March of this year, in Chicago, the exhibits will be confined to equipment of service to the management, maintenance, and materials-handling divisions of industrial plants. Again the exposition will be under the management of the Midwestern Engineering Exposition, of Chicago.

Technical sessions will present many worth-while papers on the three M's—Management, Maintenance, and Materials Handling. The materials-handling program will constitute the Fourth National Meeting of the Materials Handling Division of the American Society of Mechanical Engineers. Maintenance sessions are under the auspices of the American Society of Mechanical Engineers. Management sessions will be under the direction of this organization, the Society of Industrial Engineers, and the American Management Association. It is expected that other societies interested in management, cost accounting, and similar functions will participate. Activities will be in charge of a General Executive Committee of Cleveland men including C. M. Wilkinson, Warner Seely, T. F. Githens, and E. T. Bennington. An Advisory Committee representing the several engineering societies will aid the general executive committee. This advisory committee will include among its members some of the men who were directors of the first congress, among them G. E. Hagemann and L. C. Morrow, representing the American Society of Mechanical Engineers, and J. M. Carmody, representing the Society of Industrial Engineers.

Save Your Hands

OPERATORS of oxy-acetylene welding or cutting blowpipes should take care to protect their hands against blistering owing to the heat, and from particles of molten metal.

Most equipment dealers sell welders' gloves at reasonable prices. Plain cotton gloves costing 10c. are better than no protection, but do not last very long. An injury may cause a three- or four-day layoff and cost twenty times the price of a pair of gloves.

INDUSTRIAL ENGINEERING

L. C. MORROW, *Editor*

Vol. 88 OCTOBER, 1930 No. 10

Farewell, Useless Equipment

HOW the average man hates to throw a thing away! He'll move the old easy chair to the attic, the old kitchen table to the cellar, something else to the garage. Old clothes and old shoes will be stored and restored. Then some day he will have to move and he'll be forced to dispose of his junk by turning it over to the ash man. When that time arrives he'll not be able to remember what service he expected to receive from the old stuff and will wonder why he saved it anyway.

Many industrial plants follow the same futile procedure. Obsolete equipment piles up until space requirements force disposal. In the meantime it has been housed to no purpose, and the owner has had no use of the money that its sale as scrap would have brought. Moreover, its presence has had a bad effect on the morale of the people in the plant. As one very well known engineer said of metal-working equipment, "I believe it is thoroughly bad for shop morale to keep a lot of super-annuated machine tools standing around. They occupy valuable space that ought to be devoted to productive machines."

Decisions concerning future usefulness of equipment ought not be difficult. Better a single wrenching of the heart strings than a constant load on the mind. Once the decision has been made and the stuff is out of the way the decks are cleared for action and all hands feel that they really are going some place.

Plant Voltages Are Going Up

MOST industrial plants are continually expanding in size and facilities. To many, particularly the older ones, there comes a time when provision for increased electrical loads presents a real problem. Existing feeders are loaded to capacity, and crowded ducts or other conditions may make it a difficult and expensive job to run additional lines. Use of higher distribution and operating voltages offers one of the best solutions for this difficulty.

In the early days of the use of electrical energy in industry there was some excuse for the use of low voltages. For one thing, the amounts of power involved were low, and the problem of properly insulating equipment was more troublesome than it is today. Increase in voltage means increased power-transmitting capacity, with smaller investment in copper, and decreased losses. Nor is the accident hazard measurably increased. Workmen often are inclined to treat voltages of 110 or 220 volts with scant respect, perhaps without knowing that such voltages are highly dangerous or even fatal under certain conditions. Voltages of 2,300 and up are certain to be respected and handled with more caution.

In the case of old plants that are facing the problem of caring for increasing loads, the advisability of adopting higher voltages should be considered carefully. With new plants, or extensive additions, the problem is not whether a high voltage should be employed, but rather which of the commercial voltages in the range from, say 2,300 to 13,200, should be chosen as best suited for the service.

Choking a plant with voltages that are too low for the conditions is just about as bad as creating bottlenecks through the use of other indequate facilities.

Competitive Production Is Ahead—Look to the Handling of Materials

METHODS and equipment used in handling materials are going to constitute a prime influence in the competitive production that is ahead. Plant engineering and maintenance forces may render valuable aid to their production divisions if they will accept the challenge that their function rightfully presents.

To quote from our issue of August a year ago: "Theirs is a position from which can emanate the practical information vital to the selection of equipment that will render economical and efficient service. These men know the whys and wherefores in their own plants. They know the possibilities and the impossibilities. In no case should they fail to possess themselves of the knowledge of materials-handling equipment and the details of operation that management has a right to demand from them when materials-handling problems are up for discussion. Nor should they fail to take the initiative when they are convinced that the acquisition of such equipment will lower the cost of production in their plants."

Study and analysis of all handling operations is the first step. It should include consideration of the character and amounts of materials to be handled; features of plant layout that will aid or interfere with an ideal installation; auxiliary services; details of existing methods of handling by man power. These items apply especially when

little or no equipment is in use and the whole system must be built up.

If equipment is already installed equally practical procedure is in order: Is power consumption low enough? Is the lubrication system all it should be? Should lifts be reduced or increased? Are there sharp turns that interfere with rapid movement?

The line of attack advised here is the obvious one—it follows the dictates of common sense. If it did not, probably it would not be sound. It is therefore most likely to be followed by the men in the plant, who are devotees of common sense procedure; they are associated constantly with the physical things of the plant—the equipment—and it is wholly logical to expect from them thoroughly practicable proposals.

What Cheer the Visitor?

IT'S funny how little things affect big businesses. There's the visitors' reception room, where buyers and sellers cool their heels. What wonderful opportunity it offers for putting the caller in a frame of mind that will cause him to act favorably toward his temporary host.

Some otherwise excellent plants allow their visitors to stand until the men they are waiting for are available. Other plants provide a small bench, or maybe two; by the time some portly, thoughtless gentleman has spread himself, his coat, hat, and brief case over a bench there is not a great deal of room for the next caller. Could the portly gentleman hang up coat and hat? No —there is no hatrack.

Fixed benches—there's a trick. They keep the reception room in order; and of course they are, almost always, fixed against an open window or a red-hot radiator. Another cute little trick is to place the bench so that a window trim or some other hard object will take the man on the back of the head or neck; that'll make him keep his spine straight.

And ventilation? Too much or too little. Sit by the frequently opened door, or behind storm doors. Freeze or roast.

Ash receivers? Most likely two or three bosses or clerks will pass through the room puffing away. The visitor doesn't know whether to smoke or not; if he does smoke it's ashes back of the radiator, butts on the floor.

Then perhaps the caller is thirsty. A bubbler in the room? Slim chance, for that, or toilet, or washroom.

Not all rooms are so unattractive, so lacking in conveniences. Some plants have really studied reception, with the result that their receiving rooms are beyond reproach. And they profit accordingly, be the visitor buyer or seller—no need to argue that.

Plant engineers think primarily in terms of plant, that is, of activities and properties out in the plant. The office end is the responsibility of someone else, so they reason, if they think of the reception room at all.

A broader viewpoint would be of benefit to their employers. When rehabilitating, when planning for new construction, let them put in their oars concerning the reception room — it's an important unit.

We Have to Run Fast

WHILE Lewis Carroll put a lot of nonsense in "Alice in Wonderland," and in "Through the Looking Glass," he forcefully brings to mind certain fundamental truths. Alice and the Red Queen had been running at top speed, hand-in-hand, for some time, and then sat down under a tree to rest. Alice said, "I believe we are still just where we started from. In my country, when we run we get somewhere else." The Red Queen said, "In this country, we have to run as fast as ever we can to stay in the same place. If we want to get anywhere else, we have to run twice as fast as that." Which is about the situation in industrial plants in this country, for only strenuous effort, long sustained, will hold a plant in a commanding position.

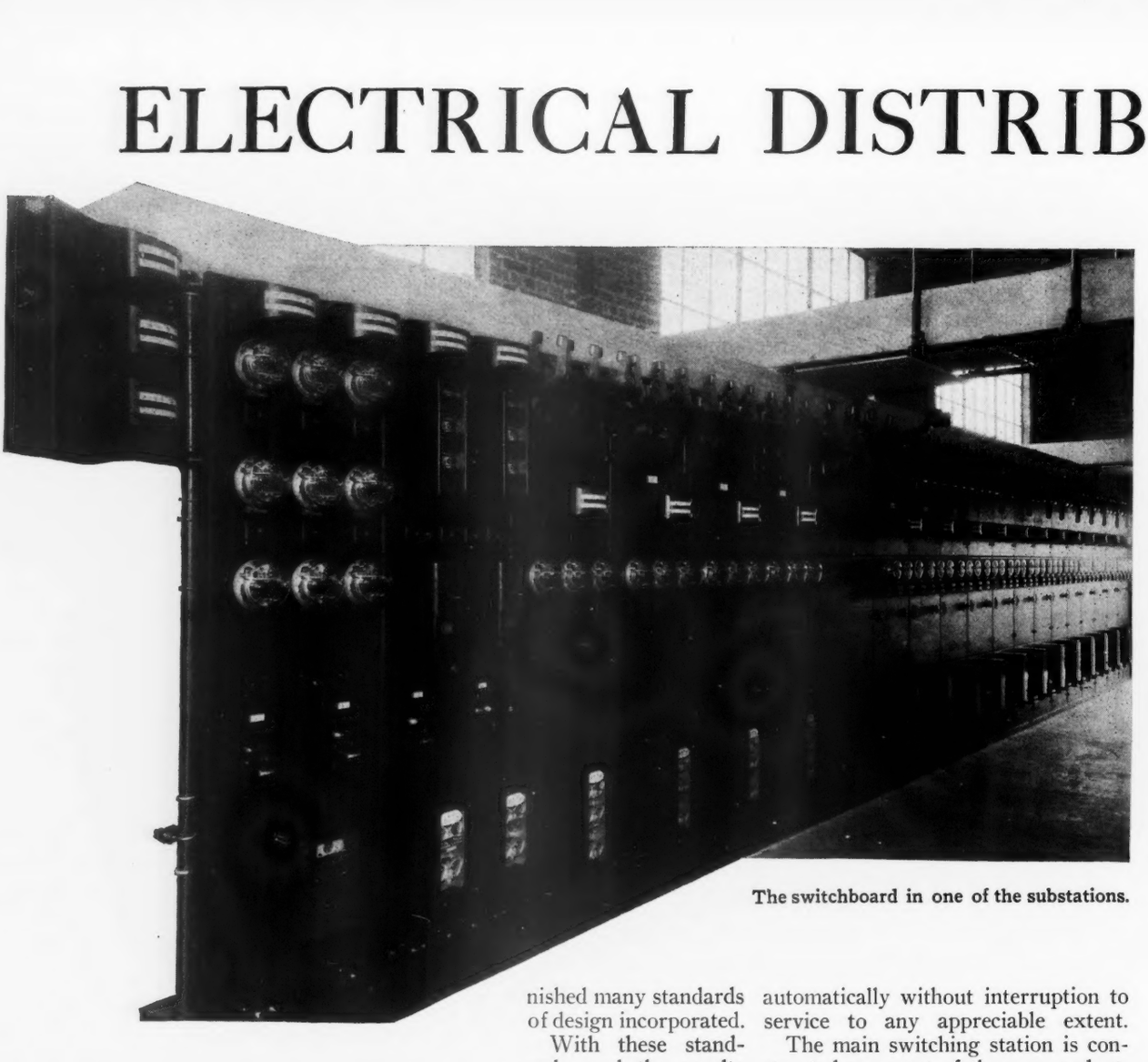
* * *

Don't be complacent; don't be satisfied with things as they are—competitors are not. Have ideas about improving conditions, push them, put them in writing, in sketches. Many schemes teeming with potential benefits have died in the heads or desks of the schemers because they were not brought out forcibly enough. Some may be too modest to bring their notions to those higher up while others become discouraged at the first belittling comment. Worst of all is the "main-strength" maintenance man who takes the attitude that he is not being paid to improve conditions and maintains that he is there simply to keep things running as they are.

* * *

These two sermonettes appeared in the August issue as part of an article. They are so pertinent and so well-presented that they are editorials in themselves. No reader should miss them. Hence they are repeated and are given a place on the editor's page. The author is R. H. Rogers, of the Industrial Engineering Department of the General Electric Company. The two extracts were parts of his talk at the Maintenance Engineers' Convention, held at Cedar Point, Ohio, during June.

ELECTRICAL DISTRIBU



The switchboard in one of the substations.

By R. G. HORNBERGER
Electrical Engineer
The H. K. Ferguson Company
Cleveland, Ohio

and

W. A. HALLIDAY
Engineer
Western Electric Company
New York, N. Y.

CONVENIENCE in operation, ease of maintenance, adaptability, and possibility of expansion are some of the factors that influenced the design of the electrical distribution system of the Point Breeze Works of the Western Electric Company. Other company plants had served as testing and research laboratories in factory planning, construction, and operation, and furnished many standards of design incorporated.

With these standards, and the results of recent research and investigations of modern practice in many plants, a system of power distribution possessing a number of unique advantages was evolved.

The original plans called for a generating plant of sufficient capacity to take care of the ultimate requirements. Later it was decided to produce steam for heating and process use only, and purchase power. The plant, however, has been designed for ultimate electric generation, if desired.

Incoming power is received through three underground feeders at 13,200 volts, three phase, 60 cycles. These three feeders, each composed of two three-conductor cables connected in parallel, have sufficient capacity for the initial power requirements. Provision has been made in the underground duct system for two additional feeders to handle the future loads. Relay protection is provided at both ends of each feeder, making it possible to cut out a defective cable automatically without interruption to service to any appreciable extent.

The main switching station is constructed as a part of the power plant, and the switching equipment has been designed so that generators may be connected to the system through the incoming line compartments with only minor changes.

Somewhat of an innovation in bus system design was adopted after considerable study of the relative merits of several standard arrangements. The main bus is split into three sections, each being connected to a synchronizing or tie bus through a reactor. This is the so-called star or radial bus scheme.

Calculations on short-circuit conditions have indicated that a fault on one section of the bus would cause a minimum voltage drop on the remainder of the system, and that the possible short-circuit current on the star-connected bus, with the proper reactors in circuit, would be lower than with other bus arrangements.

One incoming feeder serves each section of the bus, and the plant load is divided into groups. Each group is fed from one bus section.

UTION at POINT BREEZE

Continuity of service, ease of maintenance, convenient operation, and flexibility

The oil circuit breaker units are of metal-clad design. In this type the 13,200-volt bus structure, with its current transformers, disconnecting devices, small wiring, and the oil circuit breaker, are all mounted in one factory-fabricated, steel-inclosed unit. The buses are spaced for air insulation in accordance with the usual standards, and also covered with molded insulation. It has been demonstrated that this breaker will interrupt the calculated maximum possible short-circuit current possible on the system with a satisfactory factor of safety.

Safety was the paramount consideration in the adoption of this type of equipment, and it is considered practically impossible to make contact with a live part, even with the breaker removed from the structure. An elevating-platform type of truck is provided for handling the circuit breakers. Interlocks make it impossible to remove or insert a breaker in the closed position. The units are bolted together in line, and the bus connections between units are made in the field by means of clamps.

Reactors are of the oil-immersed type with the tanks mounted on trucks. Connections are made by means of bayonet connectors, so arranged that upon failure of a reactor it can be short circuited and rolled out of position. It is felt, however, that the chance of trouble is very remote.

The control board for these units has the usual mimic bus feature. For testing telephone cables it is necessary to keep the variation in frequency within very narrow limits; hence a graphic frequency meter is employed to check the variation.

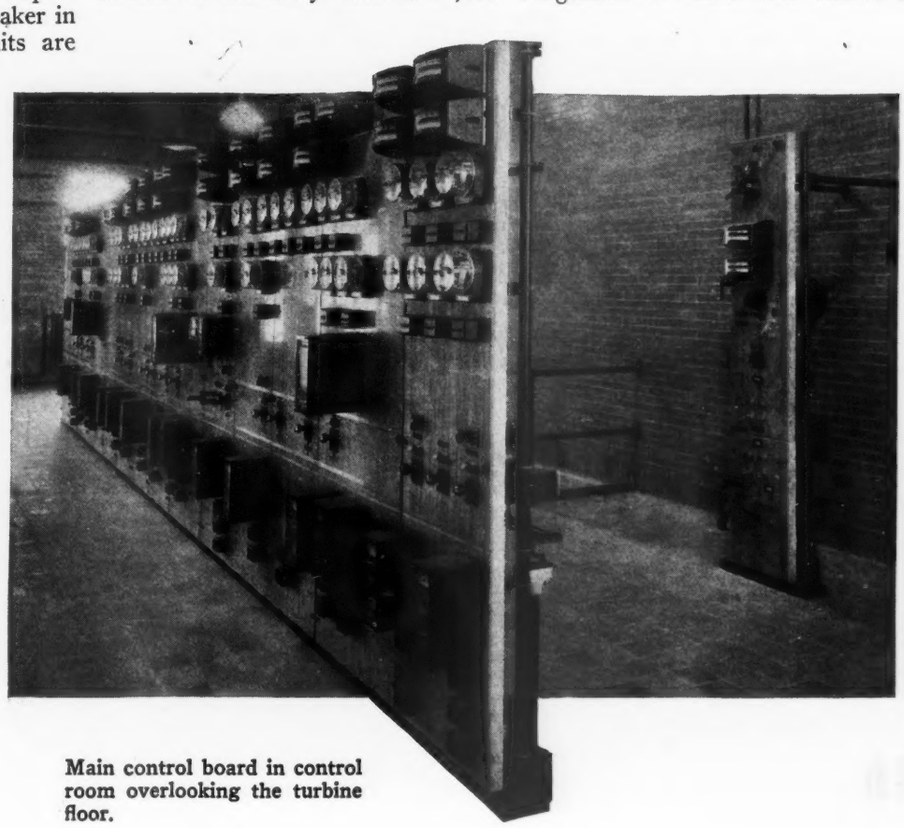
The power company's metering panels and the service battery charging panel were installed in the main control room with this control board. The main control room overlooks the turbine room so that if generating equipment is installed an unobstructed view of the turbines will be possible.

Two banks of transformers are provided in the power house. One bank is used for boiler house auxiliary equipment, and the other serves two 500-hp. air compressor motors, one 100-hp. ammonia compressor for refrigeration, the street lighting system, motor-generator sets, and pump motors. Both of these banks consist of three single-phase, oil-immersed transformers connected delta primary, 13,200 volts, and star secondary, 440 volts, with the neutral solidly grounded.

Distribution from the main switch house to the substations is through three-conductor, 400,000-circ. mil. lead-covered, sector cables in an underground duct system. The cable insulation is nominally rated at 17,000 volts, on a Y-connected system; this assures a comfortable margin of safety. The underground distribution system is carried in fiber ducts incased in concrete. In general, the duct banks are vertical and not more than two ducts wide, making possible maximum heat radiation from the cables. Special attention was paid to the design of manholes to provide an accessible racking scheme. Cables may be pulled out and replaced without disturbing those already in place.

The substations are strategically placed in the manufacturing units. Some are located on the roofs of the buildings, to release floor space. In locating substations the electrical load centers were considered first, rather than just convenient corners for the substations to fit into.

Distribution throughout the plant at 13,200 volts allows for flexibility in plant growth and the desired arrangement of units that cannot be



Main control board in control room overlooking the turbine floor.

obtained with a low-voltage system. This voltage is high enough to take care of any reasonable load within the confines of the property. There are at least two cables from the power house to every important substation, and a reverse-power protection scheme is used whereby upon failure of one cable it is automatically cut out and the load is carried on the remaining cable or cables. This insures complete continuity of operation and under normal conditions there should not be an excessive drop in voltage if a cable fails.

In the substations the energy is stepped down by single-phase, oil-immersed transformers arranged in banks and connected delta on the 13,200-volt primary and "Y" on the 440-volt secondary side, with the neutral solidly grounded. One spare transformer has been provided in each substation. All transformers in the plant have been designed with the same internal characteristics so that universal interchangeability is possible.

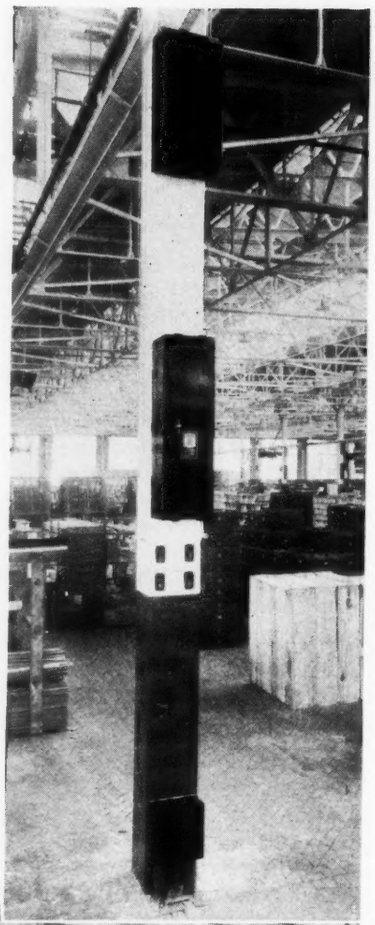
The 440-volt station bus is three-phase, four-wire. The circuit breakers on the switchboard are manually operated and are provided with shunt trip coils actuated by induction-type overload relays. They will trip free if reclosed on overload. In addition to an ammeter and watt-hour meter on each panel, a power factor meter is mounted on a swinging bracket, with connections to a transfer switch on each panel, so that the power factor of each circuit may be determined.

From the substations, power is fed into three separate distribution systems. The first system supplies the manufacturing power; the second supplies the permanent fixture, that is, sash motors, door-operating motors, unit heaters and all such devices. The third system feeds the total complement of lighting circuits.

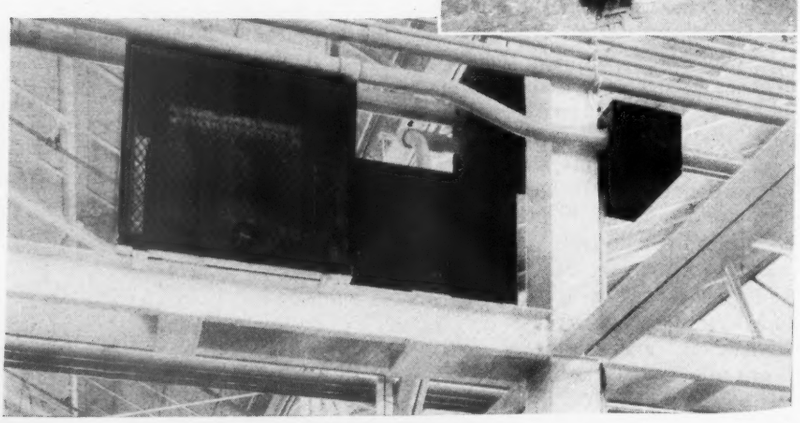
Power for manufacturing purposes is transmitted through power loop feeders with taps to distribution points on practically every building column. These distribution points contain fuse cutouts with spares at each station to provide for future branch power feeders. Distribution is made from these branch points by three methods: (*1*) Conduits buried in floor slab; (*2*) exposed conduit; (*3*) an underfloor duct system.

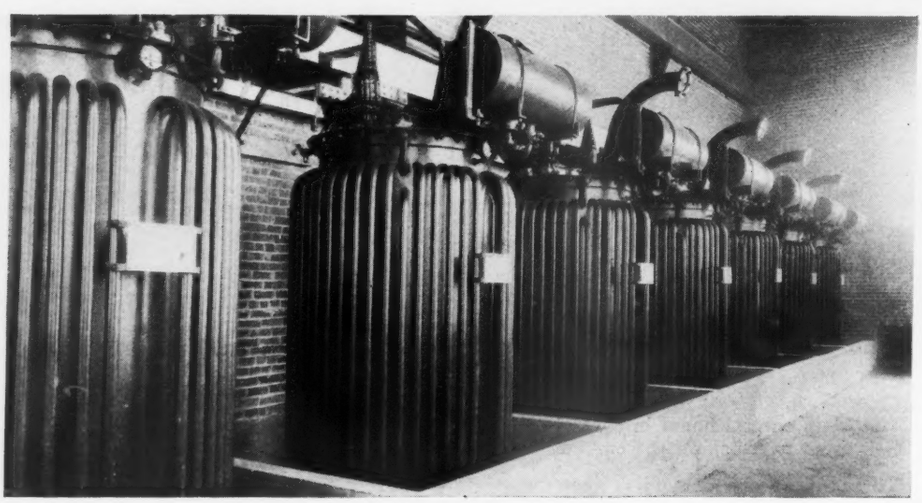
Most machines that are permanently located and definitely tied in with a process are fed through conduits in the floor slab. For machines placed close to columns, exposed conduit was frequently run from the cutout cabinet directly to the machine. All machines in the general floor area, and particularly machines that may be moved in the future, are fed through the underfloor duct system.

The 440-volt power loop feeders,



A branch panel like this is found on nearly every building column. Note the pull box at the base of the column, in which the underfloor duct terminates.





Type of transformer used on the lighting system. These transformers are mounted in the roof trusses, as shown here.

Typical installation of oil-immersed 13,200/440-volt single-phase transformers in a substation.

together with the underfloor duct system, permit every portion of the plant to be reached with power distribution circuits either now or in the future. The Western Electric Company has developed special fittings and a method of making taps from the underfloor duct system. Standard, lead-covered, armored cable is used in this duct system, which gives a very convenient and flexible method of power wiring for practically the entire plant area.

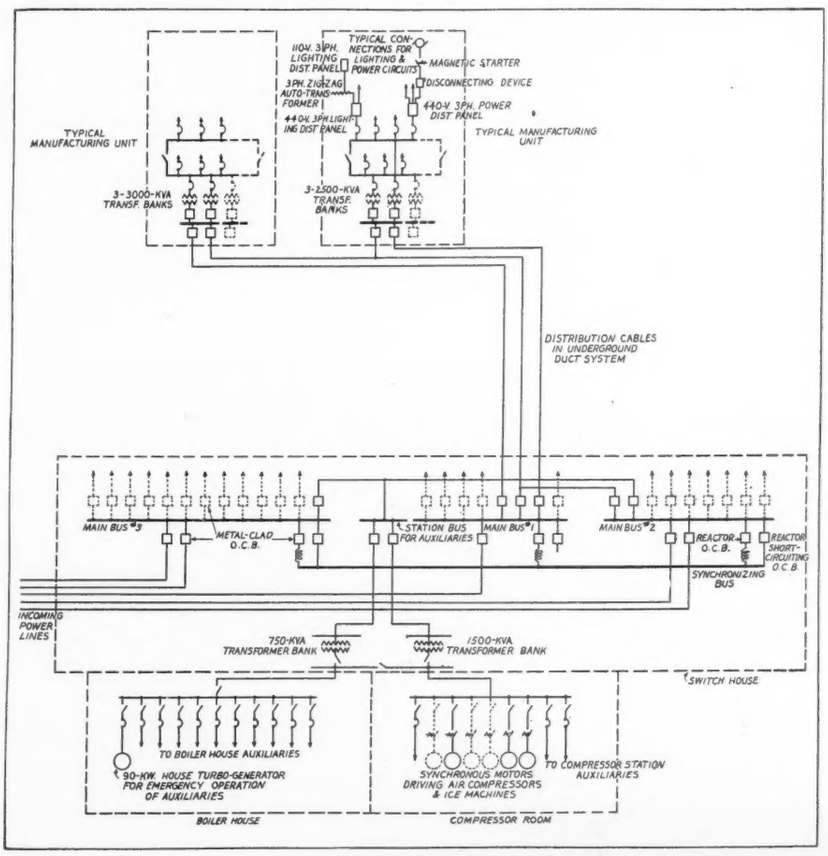
The permanent fixtures—motor-operated sash, doors, unit heaters, etc.,—are fed by a separate 440-volt system directly from the substation. Distribution is made to central points where the control for a group of these motors is mounted in the roof trusses; the push-button stations are mounted on the columns. From each operating station the equipment operated can be observed.

Means are provided for locking motor-operated rolling steel doors by a lock switch in the circuit. This lock switch can be included with the other locks on a master key system.

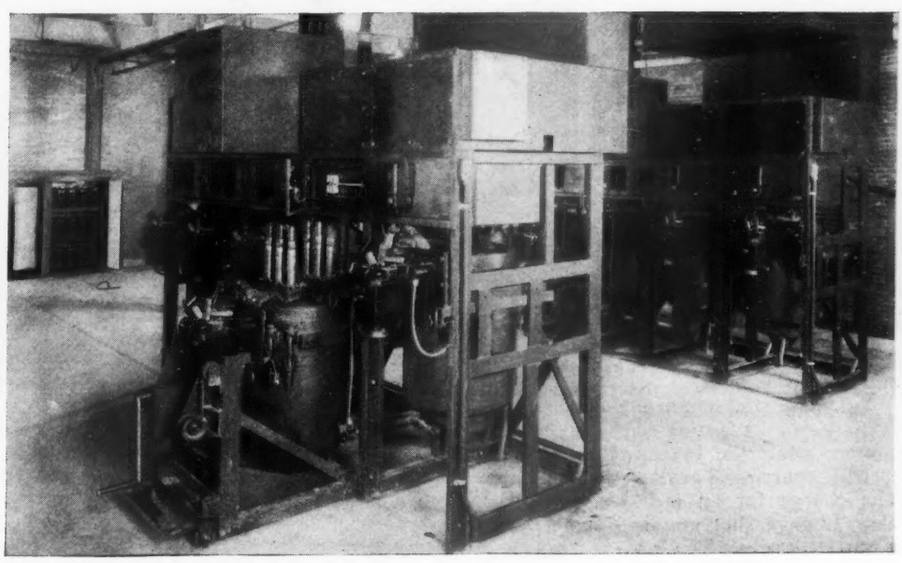
The lighting system is fed by 440-volt feeders from the substation to central distribution points at which are mounted three-phase, air-cooled, auto-transformers with zigzag connections. By distributing at 440 volts the copper economy is very good, and the use of air-cooled, zigzag transformers permitted them to be mounted in the roof trusses at strategic points.

The zigzag connection helps to balance the three phases of the load, and effectively damps out any third harmonics that may be presented at a Y-Y connection system. These transformers are of special design and their merits warrant more extensive use. They provide three-phase, four-wire secondary energy at 115 volts from line to neutral and 200 volts from line to line. Distribution is made at this voltage to the branch cabinets. This method reduces the secondary voltage drop considerably from what it would have been had 115-volts, single-phase distribution been used.

From the branch cabinets the individual branches are run as 115-volt, two-wire circuits. In general, there is one lighting transformer for every two branch cabinets. Branch lighting circuits are controlled in groups by contactors that control sections of bus in the branch cabinets.



General layout of plant distribution system.



Type of metal-clad oil circuit breaker units in main switch house.

AROUND *the* WORKS

THIS SECTION is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.

Penetration By Percussion

THOSE who are conversant with the mechanics of war, understand that a major problem is whether a projectile can be devised that will penetrate any armor, whether armor plate can be developed that will turn any projectile.

An industrial device that commercializes this penetration by percussion employs what is known as the delayed action principle, a principle somewhat analogous in its effect to pre-firing in an automobile engine so that the piston will start down with maximum pressure.

The action of the industrial device, covered herein, called the Temple gun, is therefore radically different from that of ordinary practice. The gun itself has the appearance of a lightweight riveting hammer, and its weight, which is 15 lb., permits it to be used as conveniently as an air hammer, unhampered by a hose.

The gun shown in Fig. 1 is driving a ½-in. stud into a ½-in. solid plate, with a charge of ordinary sporting powder. The recoil and consequent shock to the operator is no greater than that caused by a riveting hammer of corresponding weight. The maximum capacity of the gun is a 1½-in. stud into a 1½-in. plate.

A 1½-in. stud requires a charge of 21 grains of powder, while the 1½ in. cartridge carries 48 grains. The charge for an ordinary 12-gage shot gun is about 28 grains. The recoil, however, of the Temple gun is very much less than that of an ordinary shotgun or rifle, because of the delayed action principle that is used.

The stud and cartridge are assembled similarly to ordinary "fixed" ammunition with the difference that one end of a "breakpin" is screwed into the head of the cartridge, and the other end into a hole tapped in the inner end of the stud. For a ½-in. stud, a ¼-in. diameter breakpin is used, reduced to ⅛ in. at its center.

The projectile does not leave the gun at the moment the powder charge explodes; instead, a pressure is built up between the head of the cartridge and the end of the stud, until it reaches the capacity of the breakpin. This "lets go," and the stud leaves the gun at much higher velocity than is possible with a sporting gun using the same charge. The recoil is caused by the breaking of the pin, and not by the explosion.

Not the least remarkable feature of the Temple gun, and the one that makes its commercial use possible, is that which permits it to drive studs to a predetermined depth. The gun operates equally well under water.

How uniformly the penetration can be controlled under varying conditions, is shown in the "close up" view of the same plate, in Fig. 2. Two of the studs were driven under 180 ft. of water; one is solid, the other has a ¼-in. hole clear through it.

The reason why the end of the solid and the hollow studs have the same general appearance is because in both cases the end is drilled and tapped for the ¼-in. breakpin previously referred to.

If it is desired to use a through bolt instead of a stud, a punch may be substituted for the stud, and a clean round hole such as is shown will be the result. In this operation a slug of metal is removed, but not when driving studs or pins.

The pressure applied to the end of a driven stud that is necessary to re-

Fig. 2—Close-up of plate shown in Fig. 1. Stud 1 and stud opposite at left driven under 180 ft. of water, studs 7 and 11 on the surface. Two of the studs shown are hollow. The ⅝-in. hole was punched by the same method.

Fig. 1—Firing a ½-in. steel stud into a ½-in. solid plate to a predetermined depth.

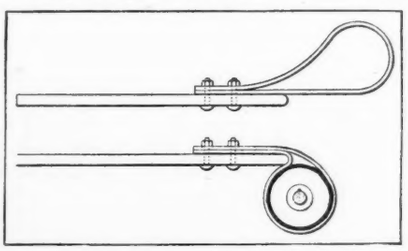
move it from a plate that corresponds in thickness to the diameter of the stud is 7 tons for the ½-in. and 20 tons for a 1½-in. stud. Obviously they cannot be pulled out because the allowance stress for a ½-in. bolt is only 760 lb. and even if a factor of safety of 10 was used its strength would be only approximately one half of 7 tons.

CHESTER B. LORD.

Wrench That Will Not Mar the Work

A HANDY tool to have around the shop for loosening or tightening round objects that do not afford a gripping surface, is the strap wrench shown in the illustration. It consists of a piece of old leather belting fastened to a long stick of hardwood by means of two carriage bolts, as shown. The stick of wood should be about 3 ft. long, and the length of the piece of belting will depend upon the size of the object upon which the tool is to be used.

By placing the belt around the object,



A non-marring wrench

as illustrated in the above drawing, and applying pressure in the direction of turning, a firm grip at long leverage is obtained.

The tool eliminates any possible chance of marring or injuring the object, and is especially effective on such things as the end guards on the arbors of polishing and grinding machines, finishing pipe, hub caps, pinions and parts of a similar nature.

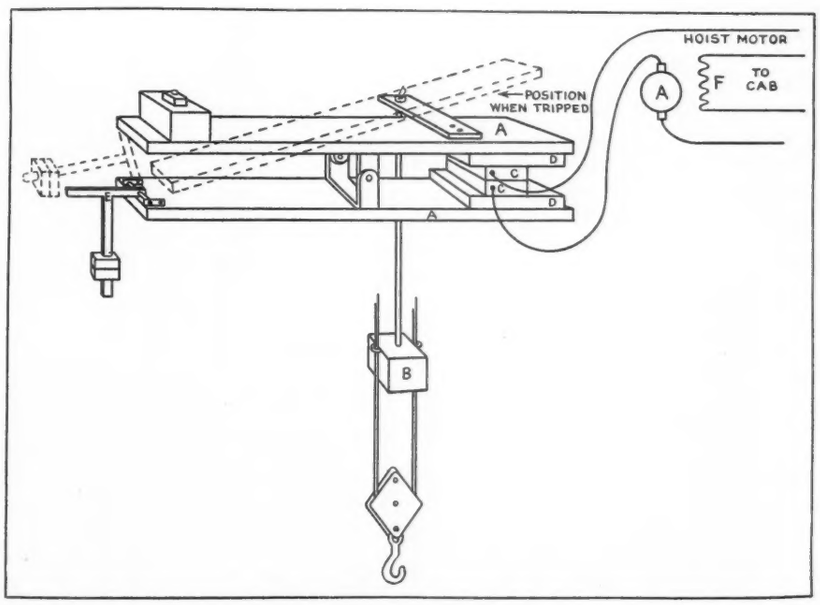
S. WOLFF
In *American Machinist.*

Chief Engineer,
American Electric Motor Company

This Crane Limit Switch Stops Overhoisting

SOME time ago I saw a crane limit switch that fulfilled all the requirements expected of it. In case the operator raised his hook too high it was necessary that he climb up on top of the crane to re-set the switch before he could lower the hook. For this reason the operator was careful not to overhoist and consequently there was no danger of breaking the cables through overhoisting. Owing to its clever construction it is worth a description.

In the sketch the limit switch is shown assembled. It consists mainly of two iron bars *A*, the lower of which



Details of a crane limit switch. The solid lines show the switch in the closed position. When overhoisting occurs the upper bar takes the position shown by the dotted lines opening the hoist-motor circuit.

is supported above the hooks and sheaves of the hoist. The upper bar is hinged to the lower bar as shown. The weight *B* keeps the two carbon blocks *C* in contact to carry the armature current. These carbon blocks are insulated from the switch parts by means of fiber strips *D*. Under normal conditions weight *B* holds the switch in a closed position, but when overhoisting takes place the upper part of the switch assumes the position shown by the dotted lines making it impossible to energize the motor. The operator is then obliged to climb up and close the switch, holding it in this position by means of trigger *E*.

When the hook descends weight *B* holds the switch closed. The trigger *E* drops out and the switch is ready to function when overhoisting takes place.

CHAS. A. PETERSON.

Chief Electrician,
Cold Spring, Minn.

What Is the Correct Center Distance?

A QUESTION recently came to me regarding correct distance between shaft centers. A user of power transmission equipment wanted to know the rule governing the distance between shaft centers where flat belt drive is used.

There was one important thing that the inquirier neglected to state and that was whether or not the load fluctuated. Was the belt subject to shock?

Distance between shaft centers is important if the load fluctuates considerably. But if there is no fluctuation pulleys may be placed as close together as their dimensions will permit. If the drive is subject to shock the distance between centers should be made proportional to the severity of the shock and vibration, and high-grade, high-friction, elastic belt always should be used. If there is no fluctuation, belt elasticity is of no value. Elasticity is a liability rather than an asset if the load is perfectly steady, because it causes belt creep, a close relative of belt slip.

The tendency today is to make the distance between shaft centers shorter and shorter, even in fluctuating drive installations.

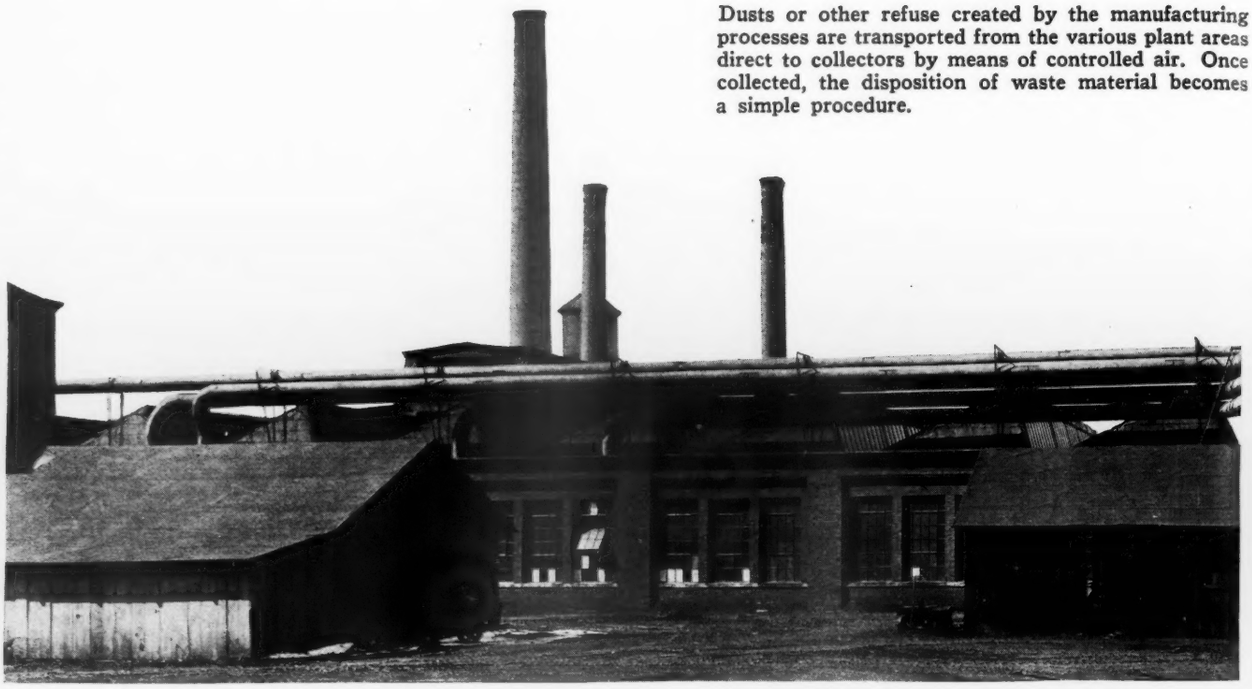
It has been repeatedly demonstrated that with a high-grade, high-friction belt the distance between centers is of less importance than ample arc of contact.

Modern wrapper pulley drives are now handling all kinds of loads at extremely short-center distances. Most of the data which are found in hand books on power transmission are based on antiquated practice with old-time, low-friction belts.

I wish to emphasize the fact that nearly everything mechanical has been improved.

The modern plain bearing of today, for example, is much superior to old plain bearings. Of course there are in use plain bearings that are no better than the plain bearings that were used 30 years ago. Likewise there are in use belts that are no better than belts used 30 years ago. But the *modern* flat belt drive that is really modern is efficient and economical.

45 Academy St.,
Newark, N. J. W. F. SCHAPHORST.



Dusts or other refuse created by the manufacturing processes are transported from the various plant areas direct to collectors by means of controlled air. Once collected, the disposition of waste material becomes a simple procedure.

CONTROLLED AIR

By DWIGHT LLOYD
Denver, Colo.

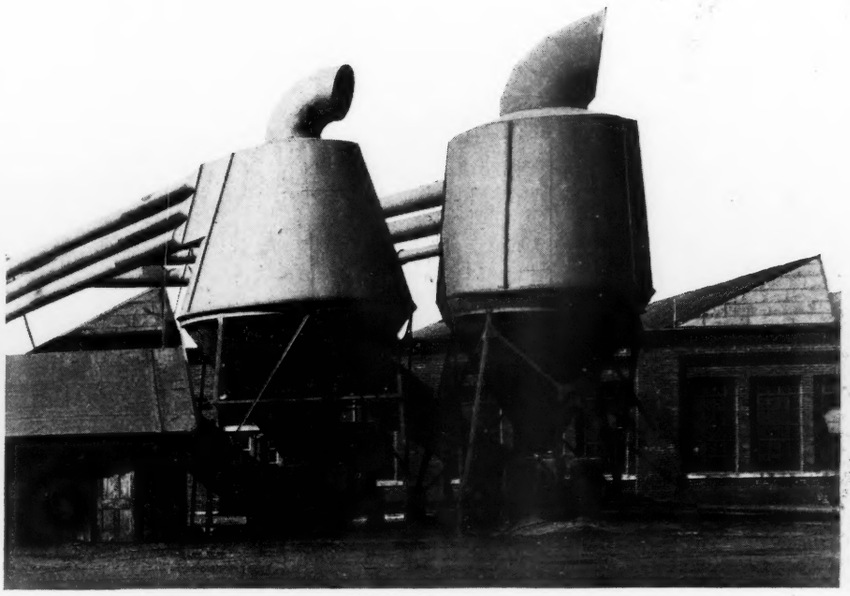
AIR at low pressure is being used in industry to a greater extent than ever before in making the atmosphere more healthful for the workmen or to reduce operating costs by doing certain jobs either faster or cheaper than can be done by any other means. The use of air as a means of removing dust, fumes, etc., from the room or work shop has long been known and in use. In other words, the principle of the exhaust system as a means of obtaining better ventilation is not new or novel, but it has been only recently that the numerous applications of this principle have been fully appreciated.

Use of air for exhausting—Exhausting steam or smoke, poisonous fumes, fine dust from artificial abrasives, wood and metal dust, etc., is one of the most important uses to which air in motion is placed. Proper ventilation made possible by the artificial removal of impurities in the air is therefore necessary for decreasing the health hazard to workmen.

In woodworking plants a light fine dust pervades the atmosphere, works through the smallest crevices and brings about a dusty condition throughout the entire building. To prevent the escape of this dust a Buffalo wood-working plant uses a dust-collecting system that operates as a single unit. There is one exhaust fan, 10 ft. 10 in. high, and one centrifugal dust collector, 24 ft. in diameter and 38 ft. high. This dust collector receives all the waste material, separates the shavings from the sawdust, and, at the option of the superintendent, delivers either product to any of four boilers, or to baling presses or to a car-loading platform. An accompanying illustration shows how exhaust pipes are installed on a tenoner for removing shavings at the plant of a Jamestown, N. Y., company.

In the manufacture of slate-covered roofing papers, a suitable exhaust system now eliminates the fume and dust condition that formerly existed. In making such products a roll of roofing felt is run through a continuous machine, then into a saturating tank where it is impregnated with asphalt. The sheet then passes under a hopper, at which point it is covered with fine slate particles that are pressed into the asphalt coating while it is still soft. In the manufacture of some grades of roofing, fine talc or mica dust is applied to each side of the sheet. Without an exhaust system the air is filled both with dust from the slate and talc and with fumes from the hot asphalt. With an exhaust system installed, however, this health hazard is eliminated, yet leaving the machines easily accessible either to make adjustments or to mend a break in the sheet. In such a system, suitably designed hoods are installed at the point where the dust and fumes originate, those hoods in turn being connected by ducts of proper design with a large centrifugal dust arrester. A fan furnishes the air in the quantity and at the pressure desired.

Air for cooling also enters into the manufacture of such roofing papers for, as the roofing material is carried



AT WORK

through a looper conveyor, a blast of cool air is usually blown over the loop by a fan which brings in outside air. An arrangement of this kind greatly accelerates the whole operation; further, the cooling blast is generally arranged so that the heating and dust-exhausting are improved. Such a dust-collecting system in a roofing mill also serves to gather together refuse material that can be used again in the process without additional labor cost.

Freedom from dust is now being obtained in grain mills and cereal factories to a point that would have been considered impossible a few years ago, all as a result of efficient dust-exhausting systems. Not only is the health hazard to workmen eliminated, but since grain mill dust is explosive the fire hazard is removed.

The presence in the air of abrasive, metallic dust resulting from heavy grinding machines is not only extremely dangerous to the health of employees, but also is the cause of undue wear on expensive tool equipment. Removal of such abrasive material from the air by the use of a suitable dust-collecting system, whereby the dust is carried to a point where it cannot possibly do harm, is a comparatively recent development in this type of manufacturing plant.

In industrial plants where paint is applied by a spray, suitable hoods, ducts and exhaust fans are now employed to advantage in removing excess paint spray and fumes. With air in motion thus removing the objectionable impurities, the workmen can perform their duties with little danger to their health.

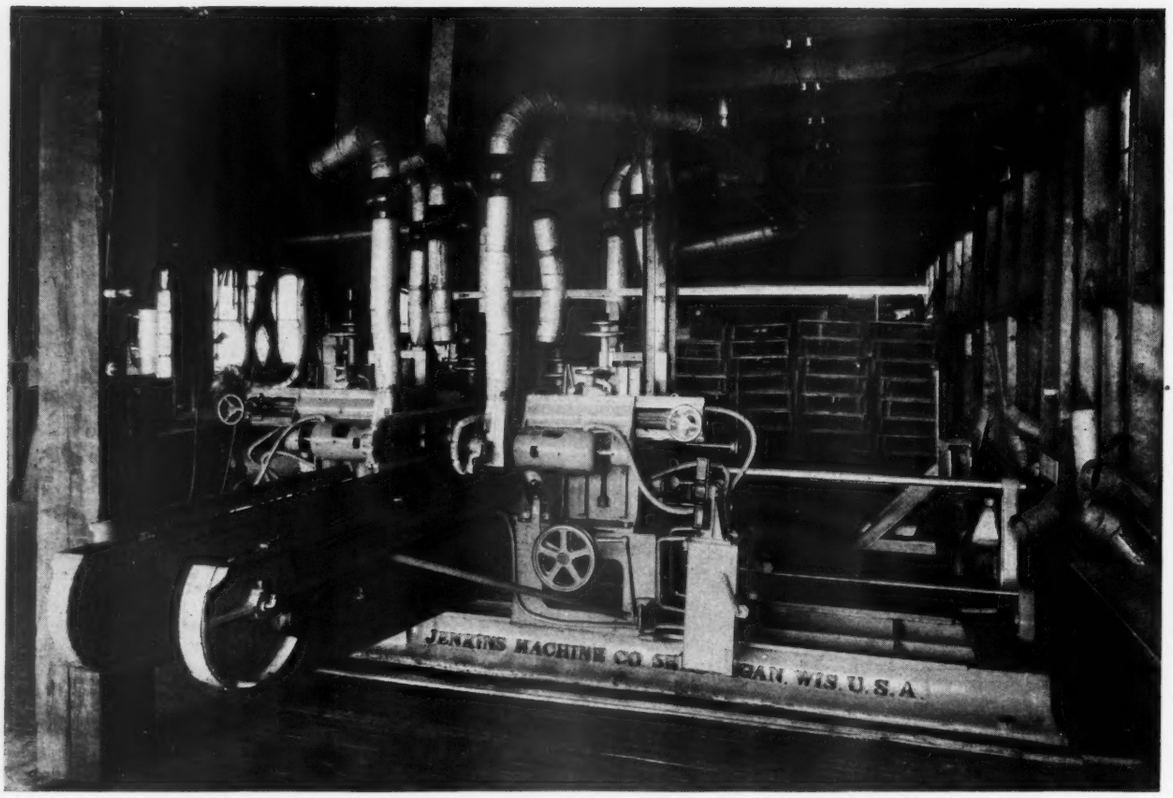
Use of air for conveying—Low-pressure, air-exhaust systems have proved successful in handling a large volume of solid and weighty materials in many manufacturing plants. Air is now being widely used to convey wool, cotton, rags, shavings, rubber and leather scrap, pulverized coal, chemicals, cement, clay, grains and many other materials. By the use of air-conveying systems substances can be carried long distances, elevated several floors and, where necessary, can be accurately fed to machines.

Use of air as a drying agent—Moving air at a low pressure also finds use as a drying agent. An interesting example is the installation in a plant where fireproofing material in a wet condition is put in the casing of steel safes. This insulation was formerly dried by the application of intense heat in naturally vented ovens. The addition to this process of a blower system for passing air into the oven at high temperature, recirculating it to the fan and mixing it with fresh air also at high temperature reduced the drying period from 48 to 24 hours. This saving of time is illustrative of the advantages gained by the recirculation of air currents in similar industrial processes. Not only is time gained and production made faster, but a great saving of floor space is also made.

Use of air in hot-blast heating—A hot-blast heating system is that which supplies heated air and distributes it throughout a building by a fan-and-duct system from a central source of heat, usually a steam coil. With this system air is recirculated or only outside air is supplied, or a desired mixture of both, as conditions may require. As changing weather dictates, the closing or opening of valves in coils gives a constant temperature with the utmost economy of fuel.

In many mills there is created surplus heat or moisture in some department as a by-product of the manufacturing process, which is used either in adding to the comfort or health of workers in other parts of the same building or in creating the uniform temperature or humidity that is necessary for better results in the manufacturing process. Other industries such as in the manufacture of textiles and in printing require a proper control of temperature and humidity. Inventive ability has made possible this control through modification of the hot-blast method for the supply of air, either warm or cool, dry or moist, to any point.

Other uses of air—In large buildings of a general nature a healthful invigorating atmosphere is obtained by exhausting the devitalized air and forcing fresh air into the building. It is recognized that the efficiency of workmen is largely dependent upon the purity of the air they breathe. Many manufacturing processes, however, create their own peculiar ventilating problems. For example, a certain type of electro-galvanizing apparatus gives off hydrocyanic and hydrochloric acid vapors, mixed with fumes of caustic soda and steam. In this instance, the exhausting of these dangerous gases is accomplished satisfactorily through hoods connected



Low-pressure air is put to work in the woodworking industry in disposing of refuse at the machine and carrying it in conduits to a central storage. This tenoner is fully equipped for dust elimination.

with roof ventilators which are based on the ejector-nozzle principle.

Air in motion has many varied applications to productive machinery and to special processes in manufacturing. For example, in a bag cleaner that is widely used in feed mills, cement plants, and by bag manufacturers, air is used at the cleaner nozzle at a high velocity, but its pressure is decreased as the dust is carried from the nozzle back to the collector.

Our Cover Picture

MAINTENANCE for the Hamilton, Ohio, plant of the Champion Coated Paper Company, shown on the cover of this issue, is under the direction of a Works Engineer, who is also Assistant Mill Manager. Twenty-five hundred men and women are employed in the plant.

The maintenance department is made up of four sub-departments, under the direction of master mechanic, building superintendent, yard boss, and machine shop boss. In the department are 188 men. The power department is a separate organization answering through the mill manager.

As the picture shows, the plant is housed in two large buildings with an office building as a separate unit. Operating floor space is 56 acres in extent. The 10 paper and cardboard machines, now steam driven for the most part, soon will be electrically driven. Power is made in a newly installed boiler that operates at a peak of 658 lb. per sq. in. Efficient use of exhaust steam will enable the making of power at $17.10 per kw.-yr. Powdered coal is the fuel.

Most of the water is taken from eight driven wells, and the consumption per day is approximately 30,000,000 gallons—more than the consumption of the entire city of Boston.

Inadequate Wiring

(Continued from page 501)

plex type. Not more than 6 duplex outlets shall be placed in one circuit, using not less than No.12B&S gage wire where the run from the panel board to the first outlet is less than 100 ft., and not less than No.10B&S gage wire where it exceeds 100 feet.

Panel Boards—Panel boards shall contain a minimum of one spare circuit position for each five active circuits or faction thereof.

There shall be at least one panel board on each floor of the building, except as otherwise specified hereafter. Wherever possible, panel boards should be so located that branch-circuit runs exceeding 100 ft. to the first outlet can be avoided.

Feeders—The current-carrying capacity of a feeder shall be great enough to supply 10 amp. at 115 volts to every circuit position provided for on the panel board or boards which it feeds.

The feeders shall be of such size that the voltage drop from the source of supply to the panel board will not exceed 1½ per cent with a load of 10 amp. at 115 volts on every branch circuit provided for.

Conduits for inclosing feeders shall be of sufficient size to permit replacing the original feeders with wires two standard B&S gage sizes greater in capacity.

EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs.

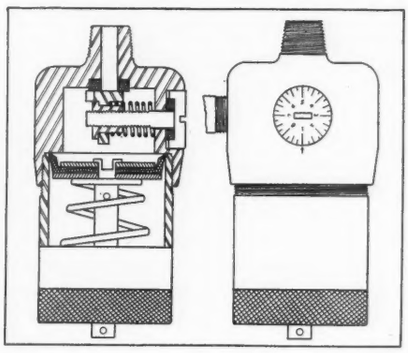
Borne Scrymser Universal Lubricator

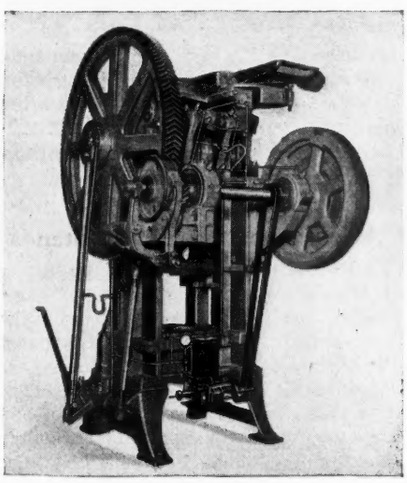
EITHER oil or grease may be used in the lubricating system introduced by the Borne Scrymser Company, 17 Battery Place, New York, N. Y. The system is comprised of two elements; a lubricator which may be used either with a hand gun or as part of a group-filling system, and a compressor arranged for either hand or power operation.

Lubricators have graduated adjusting screws for increasing or decreasing the area of the orifice to permit the delivery of a predetermined amount of lubricant. Units are made in 1-, 2-, 3-, and 8-oz. sizes.

The compressor can be operated by hand from any of four positions by means of a pump handle attached to a booster piston. By removing the pump handle and attaching the power device to the face of the flange, the compressor can be belted to the machine to which it is attached. Removing the tight and loose pulleys furnished as part of the power device permits the use of a motor which is direct-connected by means of a coupling. Provisions are made for making and breaking contact at predetermined pressures.

The reservoir, an integral part of the compressor, is equipped with an indicating rod which shows the amount of lubricant stored. A hydraulic gage, calibrated and tested by pounds, is attached to the main line at the compressor to indicate the amount of pressure required to fill pipe lines and lubricators. Bleed valves expel pocketed air.





Firestone Changeover Felloe

A UNIVERSAL changeover felloe for use in changing trucks now on solid or single pneumatic tires to dual pneumatics has been announced by the Firestone Steel Products Company, Akron, Ohio.

This unit permits the use of any size tire from the 5-in., high-pressure type to 11.25 balloons, no change being made in the wheel or spacer.

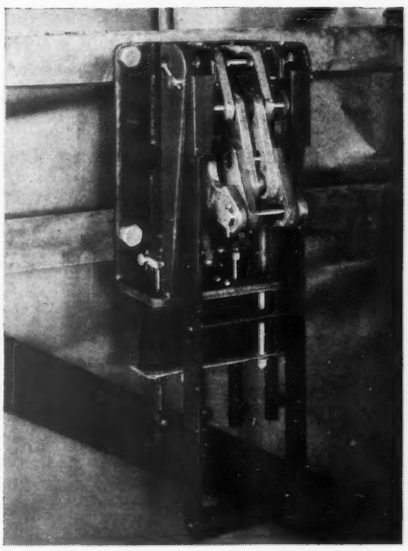
The felloe can be applied to all trucks now using cast-steel wheels by cutting off the present felloe and welding the improved model to the spoke ends. Wood wheels with the universal felloe are also available for changing over from wood-wheel single pneumatics or solids to duals.

General Electric Manual Operating Lever for Oil Circuit Breakers

A MANUAL operating lever, known as Type HD-1, for moderately heavy-duty, oil circuit breakers, has been introduced by the General Electric Company, Schenectady, N. Y. This lever is for mounting on a vertical flat surface of suitable rigidity and particularly designed for the G E Type FKR-155 line of circuit breakers.

This lever contains a compound reduction which increases the mechanical advantage as the breaker closes, so that the maximum power is exerted from the point where the contacts touch to the fully closed position. The latch contains a hardened-steel ball-bearing roller, making it sensitive to the movement of the tripping shaft, yet it is locked under normal conditions and will not permit the breaker to jar open. The latch will release under gradual movement of the tripping shaft. It does not depend on the impact imparted when the trip coil picks up.

To close, the operating lever is moved upwards 180 deg. and then brought down, the breaker closing with the downward stroke and the mechanism being trip-free at any part of this stroke. A reverse trip device protects the breaker, should the operator hesitate and back off the handle while closing. The lever is held steady in the normal downward position by a retaining spring.



Terminal Electric Shovel Truck

THE Terminal Engineering Company, New York, N. Y., has added to its line of handling equipment an electric, four-wheel-drive shovel truck for handling bulk material. It is small enough to work inside of a box car and yet dig and carry one-ton loads. The

traveling speed is 10 m.p.h. empty and 8 m.p.h. loaded.

The chassis is the same as used for the Model BC-36 heavy-duty crane. If desired, the elevating structure can be replaced with a crane boom. All main functioning units such as wheels, battery, motors, steering, braking, hoisting mechanism, etc., are interchangeable with those of all "TEC" equipment models.

Shovel buckets are made in various widths for handling materials of different specific gravities. A single hoist unit controls all functions of the bucket. An automatic stop on the upstroke speeds up the operations on short haul work and acts as a safeguard.

Uprights, on which the shovel carriage runs, may be built to any desired height. The shovel is operated from a storage battery which is in a steel compartment, placed over the wheels at the driver's end, to act as a counter balance.

There are two sets of brakes—mechanical on two wheels and electrical on four wheels—operating independently from the foot pedal and speed controller respectively.

Oxweld Aluminum Welding Rod

OXWELD Acetylene Company, 30 East 42nd St., New York, has introduced a welding rod, designated "Oxweld No. 23 Aluminum Rod," for welding either aluminum sheet or castings when the metal is tightly held in jigs, and is not free to move.

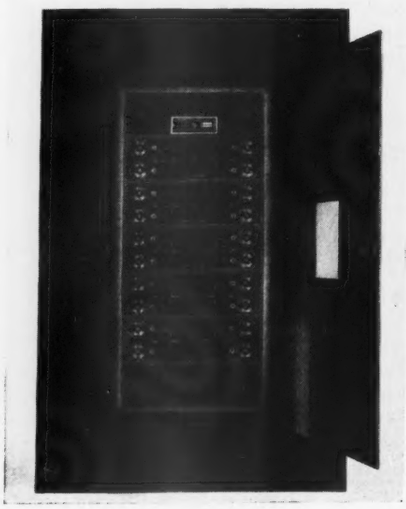
The welding rod is recommended for welding these alloys because its melting point is lower than that of the metal being welded, so that it will remain in the molten state after the base metal has solidified. The weld metal will therefore fill any voids that may have been created by the solidification and contraction of the base metal.

The aluminum rod is now available in three sizes: $\frac{1}{16}$, $\frac{1}{8}$, and $\frac{1}{4}$ inch.

Frank Adam Panelboard and Cabinet

TYPE LNTP is the latest addition to the line of panelboards and cabinets made by the Frank Adam Electric Company, 3650 Windsor Place, St. Louis, Mo. The section is of the one-piece type and is made of natural brown Bakelite with a stippled finish face. Each section contains the branch-circuit switches and N.E.C. plug-fuse connections for four, single, fuse-type branch circuits. These switches are of FA design and are rated at 30 amp. A small aluminum plate with embossed number is provided for each switch.

Main bus bars are mounted on edge on Bakelite supports. Tumbler switches are of the quick make-and-break type with double-break contacts. A mechanical "kick-off" feature permits the switch to be operated from the "on" to the "off" position independent of the operating spring. All steel parts are rust proofed.

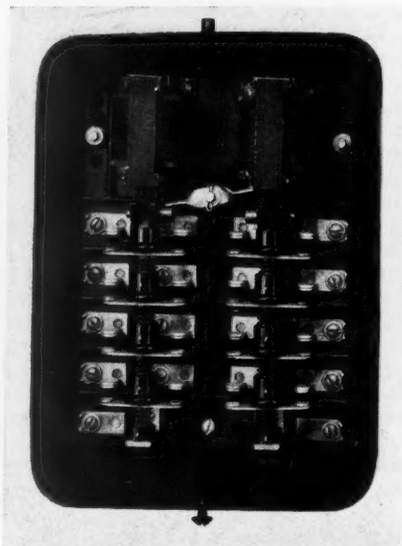


Boxes are of code thickness, galvanized steel with 4-in. wiring gutters. They are 19 in. wide inside and approximately 19½ in. wide outside. Four 5/16-in. mounting studs, upon which the panelboards are mounted, are provided in each box. Doors up to 48 in. high are provided with catch locks. Over this size, vault handle, shoot bolts, and lock are provided.

General Electric Reversing Control

REVERSING equipment for small motors, designated CR-7009-B-19, has been announced by the General Electric Company, Schenectady, N. Y. This switch is designed to handle squirrel-cage motors rated 1½ hp. at 110 volts, and 2 hp. at 220, 440, 550, and 600 volts, 25 to 60 cycles.

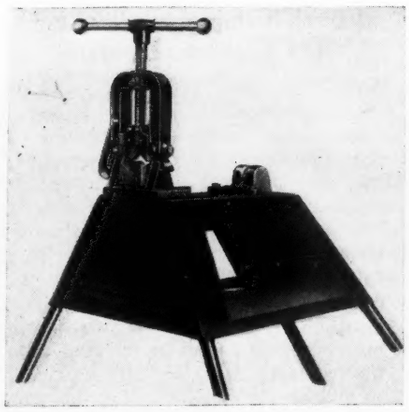
The switch consists of two contactors mechanically interlocked and having four sets of contacts and terminals. Three contact sets are for power circuits; the remaining set is for the holding circuit of the coil. Terminals are front connected and marked to facilitate wiring.



Parts are arranged on a compound base for mounting in an inclosing case. The case is suitable for wall mounting and has a removable cover, also knockouts for incoming and outgoing leads.

Armstrong Pressed-Steel Stands

PORTABLE vise and pipe-bender stands of gas-welded, heavy-gage, pressed steel are being offered by the Armstrong Manufacturing Company, Bridgeport, Conn. Model No. 81 is equipped with four removable legs. Thumbscrews lock the legs in place and prevent shifting or dropping out while the stand is being moved. Legs are



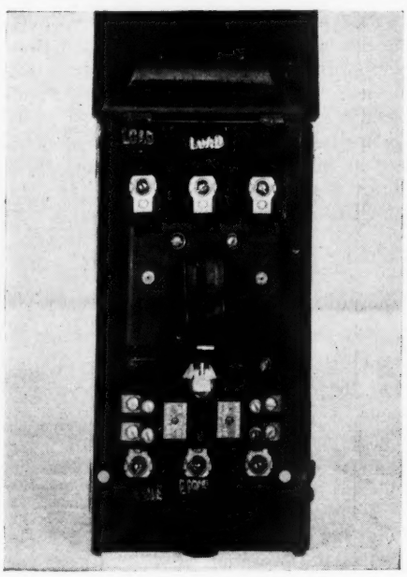
adjustable to variations in the floor's surface. The top of this stand is drilled to take any standard pipe vise (chain or hinged) to hold pipe up to and including 2½ in. in diameter.

Model No. 82 has three legs permanently attached and hinged. A spring lock holds the legs rigid when the stand is open. Legs fold together when not in use. The universal top is designed to accommodate any standard pipe vise with a capacity up to and including 3½-in pipe.

Westinghouse "Motor Watchman"

A MOTOR starting switch with resettable, automatic, overload protection, known as the WK-16 "Motor Watchman," is announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This unit is especially suitable for use with textile-loom and machine-tool motors.

Units of all ratings are inclosed in the same size box, 4⅞ in. wide, 9 in. long, and 3$\frac{11}{16}$ in. deep. The front-handle operation and the choice of top or bottom arrangement of line terminals are two additional features for both applications.



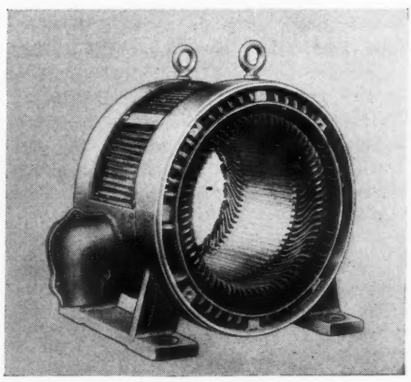
An improved method of automatic overload protection is employed. It consists of tripping the contacts by heating a preformed bimetallic disk which does not gradually deflect but maintains its shape up to a predetermined point. When this point is reached, it snaps to another position affording a positive tripping means. In its normal position the upper side is convex, the rim being rigidly held. When overheated, this side becomes concave.

This switch door is hinged at the top. Protective handle guards are arranged so that the switch may be locked in the "off" position.

Operating mechanism is of the quick make-and-break toggle type with cadmium-plated parts and non-corrosive bearings. The trip mechanism calibration and the operating time are not affected by vibration because of the positive snap action.

Reliance Adopts Mossay Cooling Principle for Large Motors

FULLY inclosed, fan-cooled induction motors in sizes ranging upward from 20 hp. at 1,200 r.p.m., and in which the Mossay principle of cooling is used, have been brought out by the Reliance Electric & Engineering Company, 1088 Ivanhoe Road, Cleveland, Ohio.

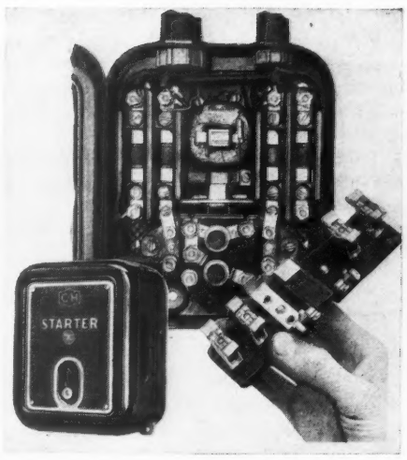


A single internal fan on the rotor circulates the confined warm air through tubes extending over the outside of the stator.

Stator windings and rotor are tightly inclosed. Fits for all inclosing parts are machined surfaces. All seals are stationary.

Cutler-Hammer "Twin Break" Magnetic Contactors

CUTLER-HAMMER, INC., 150 12th St., Milwaukee, Wis., has redesigned its entire line of Type AAA automatic starters for small a.c. motors to incorporate a recently developed "Twin Break" magnetic contactor, in which the contacts are of heavy coin silver.

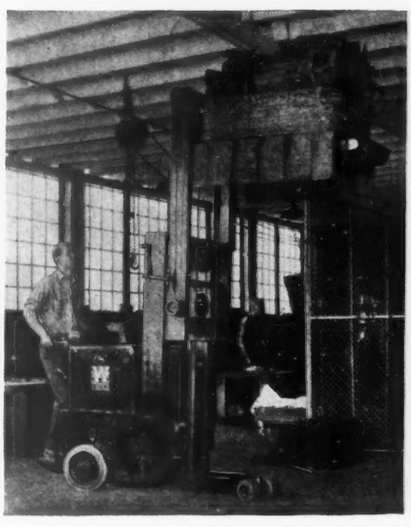


A magnetic latch has been added to prevent accidental closure of the contacts if the starter is bumped or tilted. The latch must be drawn aside by the operating magnet before the contacts can close. An improved hinge structure facilitates removing and replacing the contact board and insures correct replacing of the board before the starter can operate.

Contractors are made in three- and four-pole types. The maximum ratings for two- or three-phase are: 3 hp., 110 volts; 5 hp., 220 volts, and 7½ hp., 440 or 550 volts.

Wright-Hibbard Telescopic Tier-Lift Truck

A TELESCOPIC tier-lift truck capable of being elevated to a height of 15 ft. has been announced by the Wright-Hibbard Industrial Electric Truck Company, Inc., Phelps, N. Y. By means of a rope-operated control arranged on the side of the channels, the operator of the truck can ride on the platform and load or unload material. This control allows him to stop

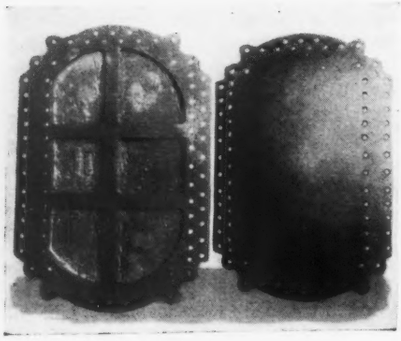


the platform at any height desired. A ladder on the side of the uprights is supplied as standard equipment so that workmen can climb to the platform if additional help is needed in loading or unloading.

This truck can be supplied with various platform sizes and various heights in lowered position.

American "Meyer" Reinforcement Unit for Dipper Doors

A CASTING of manganese steel, known as the Meyer Turtle-Back Reinforcement Unit for dipper doors, has been announced by the American Manganese Steel Company, Chicago Heights, Ill. This casting can be applied



to any dipper door that is flat inside and that has not become distorted.

Units are made for all dipper sizes. The plate is secured to the inside of the doors so as not to interfere with door braces and latch mechanisms.

Delta-Star Wire Connectors

THE Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill., announces that its line of solderless, clamp-type wire connectors, listed in bulletins 38-CB, 38-CC and 38-CD, have been approved and will be listed by the Underwriters' Laboratories.

Oxweld Two-Stage Oxygen Regulator

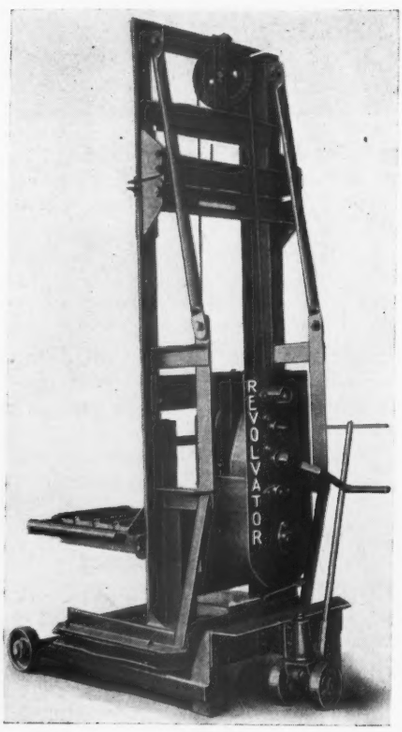
THE Oxweld Type R-43 oxygen welding regulator, recently introduced by Oxweld Acetylene Company, 30 East 42nd St., New York, N. Y., is said to guarantee a freedom from fluctuation by means of a system of two-stage pressure reduction. This reduction is accomplished through two separate and independent sets of diaphragms, valves, and springs. The full cylinder pressure of 2,000 lb. enters the regulator through a stem-type valve and is controlled by the first-stage diaphragm. In

this stage the pressure is reduced to less than 250 lb. per sq. inch.

The oxygen then passes from this first reduction assembly to a second stem-type valve and diaphragm assembly where the pressure is reduced to the working pressure desired by the operator. This pressure is regulated by the operator by means of an adjusting screw.

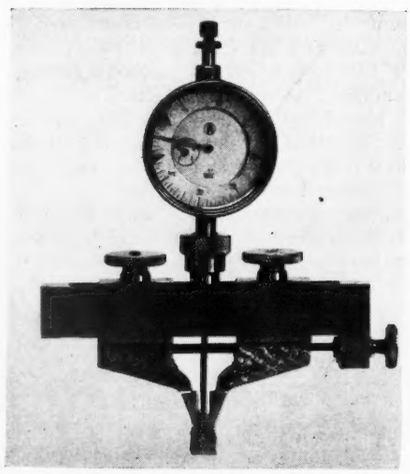
Revolvator Elevator

THE Revolvator Company, Jersey City, N. J., has introduced a portable elevator to be used as a light floor-to-floor stationary machine. The base is anchored in a depression three or four feet below the lower floor. Uprights are fastened to the base and also to the upper floor to insure stability. Safety devices furnished as standard equipment arrest the descent of the platform in the event of cable breakage, phase reversal, current failure, slack cable, or other contingencies.



Farrell-Birmingham "Sykes" Gear Tooth Comparator

AN improved type of gear-tooth comparator, called the Model E Sykes Gear-Tooth Comparator, has been announced by The Farrell-Birmingham Company, 344 Vulcan St., Buffalo, N. Y. Both jaws of this instrument are movable, while the dial indicator spindle is stationary. This is said to make setting a little more convenient. In addition, the dial gage is adjustable in the holder which permits the gage being raised or lowered. This feature makes it unnecessary to change the plunger or spindle of the dial gage



when changing from fine- to coarse-pitch gears.

Another improvement is that the jaws can be changed. The instrument can be supplied with interchangeable jaws of different pressure angles.

Sangamo Time Switch

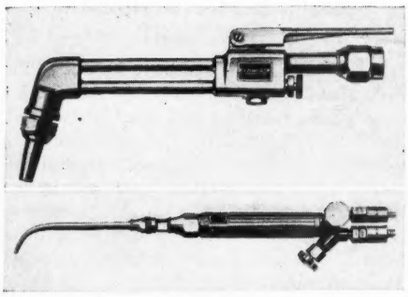
ANNOUNCEMENT has been made by the Sangamo Electric Company, Springfield, Ill., that its improved time switch, described on page 483, September issue, INDUSTRIAL ENGINEERING, is now available with a conduit-connected base.

In the former type, the base was similar to that of a watthour meter. This latter type base, it is stated, has been given the Underwriters' approval.

Oxweld W-17 Welding Blowpipe Accessories

THE Oxweld Acetylene Company, 30 E. 42nd St., New York, N. Y., has recently introduced accessories for the Type W-17 welding blowpipe.

Type CW-17 cutting attachment enables the blowpipe to do a reasonably wide range of cutting work. The attachment has the same style stem locknut as the welding head for the Type



W-17 blowpipe. The injector for the heating flame is contained in the attachment, just as the injectors are contained in the welding heads. At the rear of the attachment, near the bottom, is an adjusting screw, so that the oxygen for the heating flame may be regulated by the operator's thumb and forefinger while the blowpipe is in operation. The locknut can be tightened by hand; no wrench is necessary to join the attachment to the handle. The attachment is supplied with two cutting nozzles.

The W-17 to W-15 adaptor makes it possible to use any of the welding heads available for the W-15 sheet-metal welding blowpipe with the Type W-17 welding blowpipe handle. The end of the adaptor which fits onto the W-17 blowpipe handle is similar to the rear end of a W-17 welding head. The adaptor contains passages for the oxygen and acetylene which fit tightly against the passages in the blowpipe handle.

General Electric Live-Line Disconnecting Clamps

LIVE-line disconnecting clamps recently introduced by the General Electric Company, Schenectady, N. Y., are for making conections to main conductors from lightning arresters, for apparatus requiring occasional disconnecting, for temporary grounding of transmission lines, and for connections during construction work. They are hook-operated and rated at 200, 400, and 600 amperes.

The clamp is made of copper alloy for use on both copper and aluminum conductors. The contact surfaces of the clamps are given a special finish when the device is used with aluminum conductors. This finish reduces the electrolytic action that results when moisture enters an aluminum and copper clamped joint.

Before installing the device, the branch conductor is clamped to the back of the main casting. A switch hook is then inserted in the screw eye and that part is turned until the switch hook is firmly attached to the clamp. The switch hook with the clamp attached is then raised and the clamp is placed over the main conductor. The switch hook is then turned clockwise until the screw-bolt holds the conductor firmly in contact with the clamp.

It is unnecessary to remove the switch hook from the device while attaching the clamp or removing it from the line.

"Tricosal"

PREPARATIONS of certain concentrated chemicals in solution, trade-marked "Tricosal," to make cement mortar and concrete structures waterproof, to impart a quicker set, and a more complete hardness and high strength with a corresponding reduction of the water cement ratio, are being introduced by the Tricosal Corporation of America, 115 Western Avenue West, Seattle, Wash. Each preparation, Tricosal Normal, Tricosal A-10, Tricosal S111, Tricosal S1, Tricosal K, Fluat G, and Fluat S, has in accordance to its chemical composition various properties, but, as all are correlated, the properties of all the combined kinds of Tricosal are included in the following information.

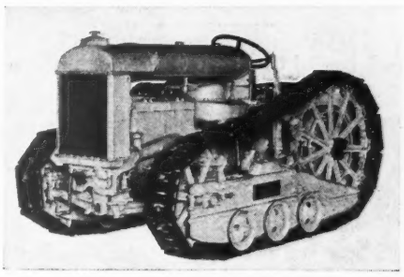
Exclusive features claimed owing to nature and application are: soluble in water; effects are permanent; concentrated in form; forms chemical combination with cement and with any surplus lime in the cement; economical to use; penetrates uniformly entire mass of concrete; harmless and easy to handle; does not deteriorate; uniform; contains no fat, oil, bituminous products, oleates or water glass; less water required.

Exclusive advantages claimed owing to qualities of concrete produced include waterproofing; resistance to acids, alkali, oil and other chemicals; quick setting and hardening; increases strength and durability; holds aggregate in suspension; sets under water, and at low temperatures; bonding power or adhesion; resistance to heat; preserves reinforcing steel; prevents efflorescence; sets and brings out color.

Specified uses list Tricosal Normal for mass concrete waterproofing, bonding, etc.; Tricosal S111 for quick-setting, quick-hardening cement; Tricosal S1 for setting cement under water; Tricosal A and K for masonry products; Fluat G and S for floor-hardening, dustproofing, and acid resisting.

Trackson Crawler for Fordson Tractors

MODEL F Trackson Crawler for the Fordson tractor, which converts the latter into a 2-ton crawler tractor, has been developed by The Trackson Company, Milwaukee, Wis.

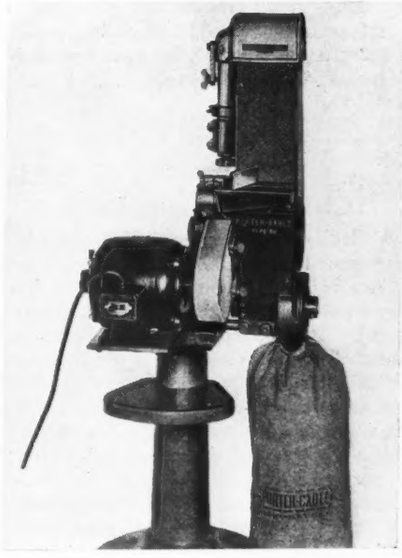


This unit gives the Fordson a track contact area of 1,100 sq. in. The crawler unit can be attached without special fitting, drilling, or machine work. No differential changes are necessary.

It is built entirely of steel and has few working parts. Tracks are made of heavy electric-alloy steel castings, heat-treated and hardened to provide extra strength and resistance to wear. Sprockets are made of alloy steel. Patented truck-wheel bearings which carry the entire weight of the tractor are of ring-oiling design. Regular Fordson speeds and clearances are retained.

Porter-Cable B-9 Belt Sander and Grinder

TYPE B-9 belt sander and grinder is the latest equipment announced by the Porter-Cable Machine Company, Syracuse, N. Y. This tool may be used in either the vertical or horizontal position. Ball bearings are used throughout and are lubricated by means of Zerk fittings. Belt speeds range between 3,000 and 4,000 f.p.m. The drive pulley is of cast iron and is



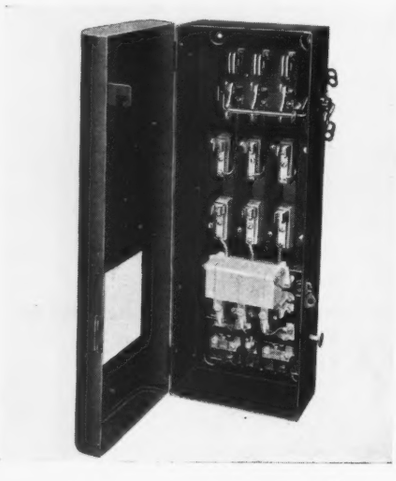
7 in. in diameter. The idler pulley is aluminum and is 4½ in. in diameter. The abrasive belt measures 6x54½ inches.

Standard equipment includes a 1-hp. motor; switch, drop cord, and plug with single-phase motor; a graduated angle gage; a dust-collecting bag; an abrasive belt for wood, also one for metal.

Industrial Controller Combination Starter

THE Industrial Controller Division of Square D Company, Milwaukee, Wis., announces a line of a.c. combination starters, known as Classes 8532K, 8536K, and 8537K.

These starters are provided with low-voltage and overload protection, also a quick make-and-break knife switch mounted in the same cabinet. Switches, equipped with arc suppressors, will break the stalled rotor current of motors

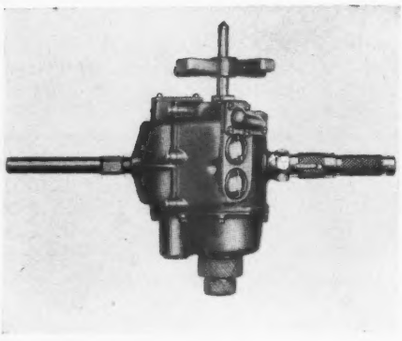


within the ratings of the starters. An interlock is provided which prevents opening the door of the cabinet unless the switch is in the "off" position.

Units can be supplied with or without fuses for branch-line protection. Starters may be controlled by push-buttons or automatic pilot switches such as pressure and float switches, thermostats, and so on.

Chicago Pneumatic No. 44 "Little Giant" Pneumatic Drills

A LINE of pneumatic drills, designated No. 44 "Little Giant," in reversible and non-reversible types, has been announced by the Chicago Pneumatic Tool Company, 6 E. 44th St., New York, N. Y. Some of the features of this line are: Long-stroke, block-type motor with valves and piston in one casting; a split crank case which permits easy removal of pistons and crank; pistons held to offset toggles by ball-and-socket joint which allows the piston to turn in the cylinder; interchangeable



valves; counter-balanced crank shaft; stainless-steel throttle parts; an automatic safety stop pin in the reversing throttle handle; cylinder casting so designed that a hole may be drilled in it for suspension in a horizontal position.

Clark Controller Acquires Sundh Electric Company

THE Clark Controller Company, Cleveland, Ohio, has acquired control of the Sundh Electric Company, Newark, New Jersey, according to a recent announcement. Operations will continue under the name of Sundh Electric Company.

Champion Bus Support

FOR 37-kv. installations where high-capacity buses are to be used, and where high mechanical strength is necessary, the Champion Switch Company, Kenova, W. Va., has developed the bus support arrangement shown.

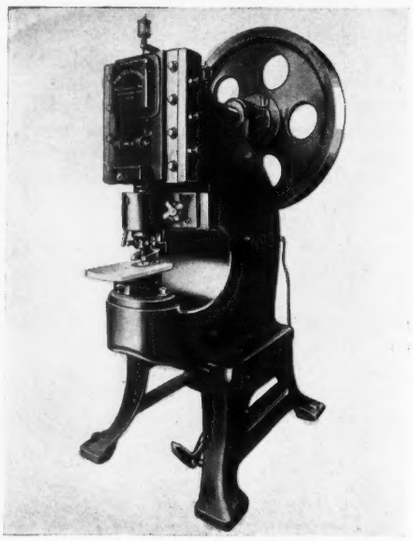
Solid-piece insulator units are clamped by means of heavy flanged bolts. The conductor clamps and spacers are made of high-strength bronze.

Campbell No. 3 Nibbling Machine

ALL kinds of shapes can be cut from sheet metal ⅜ to ¾-in. in thickness by the nibbling machine introduced by A. C. Campbell, Inc., Bridgeport, Conn., according to a recent announcement. Like the smaller units made by this company, this model works on the circular punch and die principle with a pilot to prevent the work from slipping and the punch from taking too large a bite.

A circle-cutting attachment is standard equipment. The original cutout may be used as a template for duplicate pieces.

Floor space required without motor



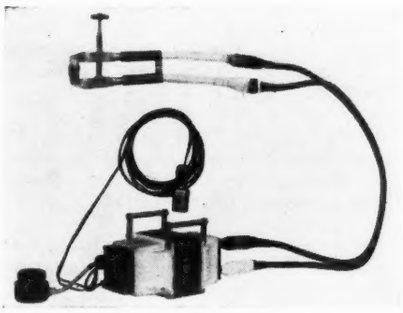
is 5 ft. x 4 ft. 2 in. Overall height is 8 ft. 6 in. The net weight is 9,000 pounds.

General Electric Brazing Equipment

ELECTRIC brazing equipment for application in all industries has been introduced by the General Electric Company, Schenectady, N. Y. Brazing is done with the heat generated by the flow of electricity through carbon blocks. The equipment consists of a transformer, a foot switch, and tongs for holding the carbon blocks and work. The sizes of the various parts depend on the size of work to be handled and joints to be made.

A typical unit involves a 5-kva. transformer weighing 45 lb., having a 220-volt primary and an 8-volt secondary. A 10-kva. transformer for heavier duty weighs 95 lb., has the same primary taps and 8-, 10- and 12-volt taps on the secondary. The secondary taps can be changed for different sizes of joints, the higher taps being used for larger sections.

Parts to be brazed are either designed with flat surfaces, or are flattened be-



fore brazing. After the work is clamped in the tongs flux is added and the current is turned on by pressing the foot switch. When the flux melts the brazing alloy is held against the hot metal until alloy flows into the joint by capillary attraction. During the process of brazing the hot alloy dissolves a thin film of the metal surfaces.

G-M Photo-Electric Cell

MANY industrial applications of the photo-electric cell are possible with the improved "Visitron" cell, introduced by the G-M Laboratories, Inc., Grace and Ravenswood Ave., Chicago, Illinois.

The sensitive surface of the cell, designated Type 75-A, is an inserted metal plate centrally located within the bulb. This type of construction, it is claimed, permits greater physical uniformity, reproducibility, and more effective electro-static shielding.

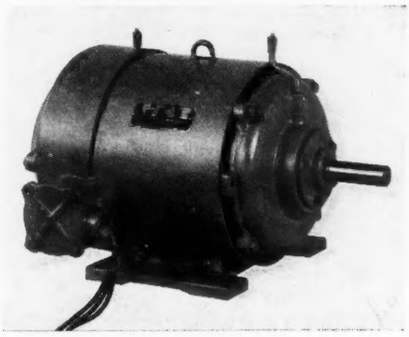
One of the chief claims made for this unit is the high sensitivity of the surface to incandescent light sources which are generally used in industrial applications.

A few of the uses are photo-electric relays for counting, sorting, grading, inspecting, alarm systems, lighting control, smoke control, and safety devices.

Louis Allis Totally Inclosed Motor

TYPE J, a totally inclosed fan-cooled motor, especially designed for severe service in automotive, chemical, process, and food industries, has been announced by The Louis Allis Company, Milwaukee, Wis. The bearing chambers are located within the sheet-steel inclosing case thus utilizing the oil seals for the bearing cartridges to exclude damaging foreign matter. Cast-iron heads are used wherein the cap screws holding the head to the frame pass through holes in the lugs that project outside of the head fit—thus preventing accidental openings in case the cap screws are left out.

A feature of design is the ease with which the motor can be taken down for inspection or repair.



Du Pont "DuLux"

A PRODUCT, known as DuLux, which is expected to prove of unusual significance in the paint and varnish field, is announced by E. I. du Pont de Nemours & Company, Wilmington, Del. It is stated that this product is based on a vehicle or film-forming material that is a specially developed synthetic chemical compound exceptionally resistant to disintegration, differing radically in this respect from the natural oils and resins generally used in the manufacture of paints, varnishes, and enamels.

Its drying time is much shorter than that of ordinary finishes, thus greatly reducing the time during which freshly coated surfaces are subject to marring by insects or dust.

DuLux is now available for industrial uses, including the finishing of machinery and the coating of structural steel, bridges, and other uses where resistance to weathering and corrosion is required.

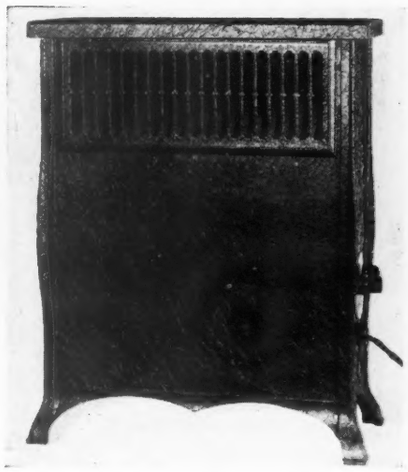
"Carey Aluminite"

HIGH-temperature, heat-insulating material, known as "Carey Aluminite," is being marketed by the Phillip Carey Company, Cincinnati, Ohio. The line consists of two types of materials; one for temperature up to 2,000 deg. F., the other for temperatures to 2,500 deg. Fahrenheit.

For the present, the material is being furnished in blocks 2½ in. thick, 9 in. wide and 36 in. long; these dimensions having been adopted because the insulation is intended for use in connection with fire-brick construction. Each block is equivalent in size to eight standard bricks.

Air-Way Electric Appliance "Aeriet"

A PORTABLE, electric heating unit, known as the Air-Way "Aeriet," for creating and controlling air conditions and temperatures is being marketed by the Air-Way Electric Appliance Corporation, Heating Division, Toledo, Ohio.

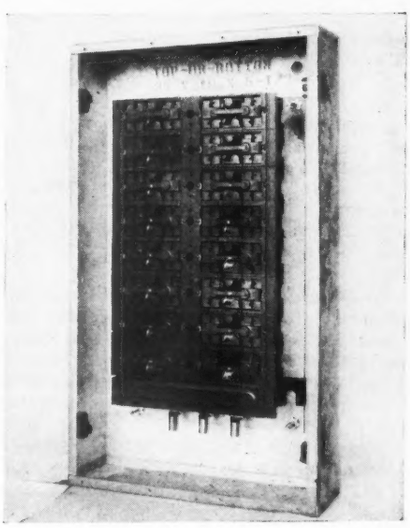


Essentially, the unit consists of a specially designed capacitor-type motor, a fan, and a non-glowing, electric heating element. It weighs 32 lb., and can be plugged into the nearest light socket. The unit is started, regulated, and controlled by means of a switch located at the side of the metal housing.

Bull Dog Panelboard

AN addition to its line of dead-front "Saftofuse" (fusible switch) units has been announced by the Bull Dog Products Company, 7610 Jos. Campau Ave., Detroit, Mich. This is a double-branch, three-pole, 30-amp., Bakelite unit as shown in the upper illustration.

The lower photograph shows a sixteen-circuit, 3/3-wire panel consisting of assemblies of Saftofuse units. The cabinet is 32 in. high, 19 in. wide, and 5½ in. deep.



TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog described, as given in these columns.

* * *

(261) SUBSTATION EQUIPMENT—Bulletin 38-F, Type F, clamp-type busbar and conductor fittings for round conductors.—Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill.

(262) STARTING EQUIPMENT — Three new catalog pages for catalog 14: Page 28A, magnetic motor starting switches in cast iron boxes; page 47C, meter service and range switches; page 50A, meter service breakers.—The Trumbull Electric Manufacturing Company, Plainville, Conn.

(263) MATERIALS HANDLING — Special publication 1873, 28 pages, a photograph, a drawing, and data covering the performance and the electrical and mechanical construction of each of 17 mine locomotives and 7 industrial locomotives.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(264) ARC WELDING—Bulletin 901, 8 pages, design, construction, and ratings of Burke arc welders.—Burke Electric Company, Erie, Pa.

(265) FLOW METERS — "Get It On Paper," a broadside describing Brown electric flow meters.—The Brown Instrument Company, Wayne & Roberts Aves., Philadelphia, Pa.

(266) MINIATURE INSTRUMENTS—Publication GEA-1239, listings of the GE line of miniature instruments for panel mounting.—General Electric Company, Schenectady, N. Y.

(267) SPEED REDUCERS—Catalog B-1 is a complete revision of the planetary line of speed reducers, and catalog C-1 is a complete revision of the worm gear line. Both catalogs contain not only construction and engineering data on the speed reducers, but also their application.—Gears and Forgings, Cleveland, Ohio.

(268) DRAFTING—Booklet, 32 pages, "Fundamentals of Pattern Drafting for Sheet Metal Shops."—Sheet Metal Shop Service Bureau, The Armco Distributors' Association of America, Middletown, Ohio.

(269) INSULATION — "The Micabond Manual," 72 pages, a brief history of Mica; its sources and use, and "Micabond," a manufactured mica.—Chicago Mica Division, Continental-Diamond Fibre Company, Newark, Del.

(270) OVENS — Bulletin 10, 4 pages, Despatch continuous conveyor ovens.—Despatch Oven Company, 622 Ninth St., S. E., Minneapolis, Minn.

(271) PYROMETERS — Catalog 15A, 104 pages, 141 illustrations, Brown indicating recording and automatic control pyrometers.—The Brown Instrument Company, Philadelphia, Pa.

(272) LUBRICATION — Bulletin, details and applications of the Farval centralized system of lubrication.—Lubrication Devices, Inc., Battle Creek, Mich.

(273) CRANE EQUIPMENT — Publication GEA-1210, "Electric Equipment for Cranes." — General Electric Company, Schenectady, N. Y.

(274) PAINT—Bulletin, 28 pages, "Industrial Technical and Architectural Finishes."—Norfolk Paint & Varnish Company, Norfolk Downs, Mass.

(275) CONVEYOR DRIVES—Book 1191, 32 pages, a complete line of screw conveyor drives.—H. W. Caldwell & Son Company, 2410 West 18th St., Chicago, Ill.

(276) MOTORS—Leaflet 2124, Type ARZ totally enclosed, fan-cooled, squirrel-cage, induction motors.—Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

(277) GROUND GLASS JOINTS—Department of Commerce publication, "Interchangeable Ground Glass Joints." Commercial Standard CS21-30.—Department of Commerce, Bureau of Standards, Washington, D. C.

(278) PUMPS — Illustrated booklet, 19 pages, "Warren Pumps and the Organization Behind Them." — Warren Steam Pump Company, Warren, Mass.

(279) COMPRESSORS—Bulletin P-14, centrifugal blowers; bulletin P-5, compressors. — Elliott Company, Morris Bldg., Pittsburgh, Pa.

(280) LIGHTING — Industrial and commercial catalog No. 4, 46 pages, "Quad" lighting units.—Quadrangle Manufacturing Company, 32 So. Peoria St., Chicago, Ill.

(281) ELECTRICAL EQUIPMENT—Bulletin CT4, 12 pages, Burke clamp-type, positive-grip, tee connectors.—Burke Electric Company, Erie, Pa.

(282) SHEET STEEL—Booklet, 16 pages, Armco electrical sheet steel grades.—The American Rolling Mill Company, Middletown, Ohio.

(283) CENTRAL STATION — Publication, "Modern Central Stations," sixth of a series, a collection of articles selected from technical magazines of interest to engineers and others in the field of power generation.—Ingersoll-Rand Company, 11 Broadway, New York, N. Y.

(284) SPEED REDUCERS—Bulletin 230, 68 pages, the complete Falk line of parallel-shaft, herringbone speed reducers carried in stock for immediate shipment.—The Falk Corporation, Milwaukee, Wis.

(285) ELECTRICAL TOOLS — Catalog and price list No. 36, 64 pages, a complete line of electric drills, grinders, buffers and polishers.—The Standard Electrical Tool Company, 1938 West 8th St., Cincinnati, Ohio.

(286) MANGANESE STEEL FEEDERS — Folder, 8 pages, steel feeders designed to handle abrasive bulk materials in large tonnages. — Stephens-Adamson Manufacturing Company, Aurora, Ill.

(287) WATER COOLER — Folder, Merco bottle-type cooler and Merco pressure, bubbler-type cooler. — National Electric Refrigerator Corporation, 304 Penn Ave., Scranton, Pa.

(288) UNIT HEATERS — Bulletin, construction and installation details on Wolverine unit heaters and Wolverine copper radiation. — Wolverine Tube Company, 1411 Central Ave., Detroit, Mich.

(289) REFRACTORIES—Folder, "Kingdo" wet, high-temperature refractory patch.—Southern King Refractories, Inc., 489 Stephens St., S. W., Atlanta, Ga.

(290) ARC WELDING—Publication S. P. 1879, 32 pages, the strength of structural-steel welded joints, design data, test and inspection data, building code, estimating costs, and bridge specifications.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Coming Events

Second National Industrial Congress featuring Management, Maintenance and Materials Handling—Public Auditorium, Cleveland, Ohio, April 13 to 18, 1931, inc. In conjunction, Second National Industrial Equipment Exposition. Concerning technical sessions address P. T. Wetter, American Society of Mechanical Engineers, 29 West 39th St., New York City. Exposition under management Midwestern Engineering Exposition, 308 West Washington St., Chicago, Illinois.

Ninth National Exposition of Power and Mechanical Engineering—Grand Central Palace, N. Y., Dec. 1 to 6, 1930. Managers, International Exposition Company.

Fifth Midwest Engineering and Power Exposition — Coliseum, Chicago, Feb. 10 to 13, 1931. Managers, Midwest Engineering Exposition, Inc., 308 West Washington St., Chicago, Ill.

National Fire Protection Association —35th annual meeting, Toronto, Can., May 11 to 17, 1931. Association headquarters, 60 Batterymarch St., Boston, Mass.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Motor Wiring Tables

(Continued from the September issue)

THREE-PHASE SQUIRREL-CAGE INDUCTION MOTORS

Voltage	Hp.	Full load Amperes	Wire Size Gage No. or circular mils			Conduit size	Running protection		Max. rating branch circuit fuses		Voltage drop per 100 ft. (single distance) r. c. wire
			Rubber covered	Varnished cambric	Slow-burning	Inches	Max. fuse rating** Amperes	Max. setting time limit protective device Amperes	Full voltage starting Amperes	Reduced voltage starting Amperes	Percent
	½	5.0	14	14	14	½	8**	6.25	15	15	2.1
	¾	5.4	14	14	14	½	8**	6.75	20	15	2.2
110	1	6.6	14	14	14	½	10**	8.25	20	20	2.7
	1½	9.4	14	14	14	½	12**	11.75	30	25	3.9
	2	12.0	14	14	14	½	15**	15.00	40	30	5.0
	½	2.7	14	14	14	½	4**	3.50	15	.....	0.59
	¾	3.0	14	14	14	½	4**	3.75	15	.....	0.66
	1	3.5	14	14	14	½	6**	4.50	15	.....	0.77
	1½	5.0	14	14	14	½	8**	6.25	15	15	1.1
	2	6.4	14	14	14	½	8**	8.00	20	20	1.4
	3	9.5	14	14	14	½	12	12.00	30	25	2.1
	5	16	12	12	14	¾*	20	20.00	50	40	2.2
	7½	23	8	10	10	1*	30	29.00	70	60	1.25
	10	29	6	8	8	1¼*	40	36.50	90	80	1.0
	15	40	6	6	8	1¼*	50	50.0	125	80	1.4
208	20	55	4	4	6	1¼	70	69.0	175	110	1.2
	25	68	2	4	4	1½	90	85.0	225	150	0.92
	30	82	0	2	2	2	110	102.5	.....	175	0.70
	40	107	00	0	1	2	150	134.0	.....	225	0.72
	50	133	000	00	0	2	175	166.5	.....	300	0.71
	60	158	0000	000	0	2½	200	197.5	.....	350	0.67
	75	191	250,000	0000	000	2½	250	239.0	.....	400	0.69
	100	260	400,000	300,000	0000	3	350	325	.....	600	0.59
	125	330	600,000	500,000	350,000	3½	450	413	.....	660***	0.50
	150	382	700,000	500,000	400,000	3½	500	478	.....	764***	0.49
	200	509	1,000,000	800,000	600,000	4	.....	637	.....	1018***	0.46
	½	2.5	14	14	14	½	4**	3.25	15	.....	0.5
	¾	2.8	14	14	14	½	4**	3.50	15	.....	0.6
	1	3.3	14	14	14	½	6**	4.25	15	.....	0.7
	1½	4.7	14	14	14	½	8**	6.00	15	15	1.0
	2	6	14	14	14	½	8**	7.50	20	15	1.2
	3	9	14	14	14	½	12	11.25	30	25	1.9
	5	15	12	12	14	½	20	18.75	45	40	2.0
	7½	22	8	10	10	1*	30	27.50	70	60	1.1
	10	27	8	8	8	1*	35	34.00	80	70	1.4
	15	38	6	6	8	1¼*	50	47.5	125	80	1.2
220	20	52	4	4	6	1¼	70	65.0	175	110	1.1
	25	64	3	4	4	1¼	80	80.0	200	150	1.0
	30	77	1	2	3	1½	100	96.00	.....	175	0.8
	40	101	0	0	2	2	125	126.0	.....	200	0.9
	50	125	00	00	0	2	175	156.5	.....	250	0.6

*Conduit one size smaller may be used under certain conditions. N.E.C. 503-q.
**Motors of 2 hp. or less may be protected by branch circuit fuses only. N.E.C. 808-A, exception (1).
***Circuit-breaker settings. Fuses not permitted. N.E.C. 805-1.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Motor Wiring Tables

(*Continued from the preceding page*)

THREE-PHASE SQUIRREL-CAGE INDUCTION MOTORS—*Continued*

Voltage	Hp.	Full load Amperes	Wire Size Gage No. or circular mils			Conduit size	Running protection		Max. rating branch circuit fuses		Voltage drop per 100 ft. (single distance) r. c. wire
			Rubber covered	Varnished cambric	Slow-burning	Inches	Max. fuse rating** Amperes	Max. setting time limit protective device Amperes	Full voltage starting Amperes	Reduced voltage starting Amperes	Percent
	60	149	0000	000	0	2½	200	186.0	.....	300	0.6
	75	180	0000	0000	00	2½	225	225.0	.....	400	0.7
220	100	246	400,000	300,000	0000	3	300	308	.....	500	0.5
	125	310	500,000	500,000	300,000	3	400	388	.....	620***	0.5
	150	360	600,000	500,000	350,000	3½	450	450	.....	720***	0.5
	200	480	900,000	700,000	500,000	4	600	600	.....	960***	0.5
	½	1.3	14	14	14	½	2**	1.75	15	.....	0.14
	¾	1.4	14	14	14	½	2**	1.75	15	.....	0.15
	1	1.7	14	14	14	½	3**	2.25	15	.....	0.18
	1½	2.4	14	14	14	½	3**	3.00	15	15	0.25
	2	3.0	14	14	14	½	4**	3.75	15	15	0.31
	3	4.5	14	14	14	½	6	5.75	15	15	0.47
	5	7.5	14	14	14	½	10	9.50	25	20	0.8
	7½	11	14	14	14	½	15	13.75	35	30	1.1
	10	14	12	14	14	½	20	17.50	45	35	0.9
	15	19	10	12	12	¾	25	23.75	60	50	0.8
440	20	26	8	8	8	1*	35	32.50	80	70	0.7
	25	32	6	8	8	1¼*	40	40.00	100	70	0.5
	30	39	6	6	8	1¼*	50	49.0	.....	80	0.6
	40	51	4	4	6	1¼	70	64.0	.....	110	0.5
	50	63	3	4	4	1¼	80	79.0	.....	125	0.5
	60	75	1	3	3	1½	100	94.0	.....	150	0.38
	75	90	0	1	2	2	110	112.5	.....	200	0.36
	100	123	000	00	0	2	175	154.0	.....	250	0.31
	125	155	0000	000	0	2½	200	194	.....	350	0.31
	150	180	0000	0000	00	2½	225	225	.....	400	0.36
	200	240	350,000	250,000	0000	3	300	300	.....	500	0.29
	½	1.0	14	14	14	½	2**	1.25	15	.....	0.08
	¾	1.1	14	14	14	½	2**	1.50	15	.....	0.09
	1	1.3	14	14	14	½	2**	1.75	15	.....	0.11
	1½	2.0	14	14	14	½	3**	2.50	15	15	0.17
	2	2.4	14	14	14	½	3**	3.00	15	15	0.20
	3	4.0	14	14	14	½	6	5.00	15	15	0.33
	5	6	14	14	14	½	8	7.50	20	15	0.50
	7½	9	14	14	14	½	12	11.25	30	25	0.75
	10	11	14	14	14	½	15	13.75	35	30	0.91
550	15	15	12	12	14	½	20	18.75	45	40	0.78
	20	21	8	10	10	1*	30	26.25	70	60	0.43
	25	26	8	8	8	1*	35	32.50	80	70	0.54
	30	31	6	8	8	1¼*	40	39.0	.....	70	0.40
	40	40	6	6	8	1¼*	50	50.0	.....	80	0.52
	50	50	4	4	6	1¼	60	62.5	.....	100	0.41
	60	60	3	4	4	1¼	80	75.0	.....	120	0.39
	75	72	2	3	4	1½	90	90.0	.....	150	0.37
	100	98	0	0	2	2	125	122.5	.....	200	0.32
	125	124	000	00	0	2	175	155	.....	250	0.25
	150	144	0000	00	0	2½	200	180	.....	300	0.23
	200	195	250,000	0000	000	2½	250	244	.....	400	0.27